8th Annual Science and Engineering Technology Conference/
DoD Technology Expo

17 - 19 April 2007

North Charleston, South Carolina

Agenda

Tuesday, 17 April 2007

Preliminary Session: *Opportunities for Collaboration*

- FY 2008 President's Budget Request for DoD S&T Program, *Mr. Robert Baker,* Deputy Director, Plans & Programs, ODDR&E
- Joint Capability Technology Demonstration (JCTD) Program, *Mr. John J. Kubricky,* Deputy Under Secretary of Defense for Advanced Systems & Concepts
- T&E/S&T Program, *Mr. Derrick Hinton,* T&E/S&T Program Manager, Defense Test Resource Management Center
- DoD Basic Research Program with a Focus on Academia, *Dr. William S. Rees, Jr.,* Deputy Under Secretary of Defense for Laboratories and Basic Sciences
- International Collaboration, *Dr. Tony Sinden,* Counsellor for Defence Science & Technology, British Embassy

CONFERENCE OPENING:

- **Keynote Address:** *Honorable John J. Young, Jr.,* Director, Defense Research and Engineering

Session I: *Air Force Space Systems for Transformation*

- Air Force Space Transformation, *Brigadier General Ellen M. Pawlikowski,* USAF, Command, Military Satellite Communications Systems Wing, USAF Space and Missile Systems Center
- Responsive Space Technology, *Dr. Robert Morris,* USAF, Acting Chief Scientist, Air Force Research Laboratory, Space Vehicles Directorate
- Program Office Perspective on Transformational Space, *Colonel Rich White,* USAF, Director, Developmental Planning, USAF Space and Missile Systems Center
- Industry View and Experience with Responsive Space, *Mr. Stuart Linsky,* Vice President, Satellite Communications, Northrop Grumman Space Technology
- User Perspective on Space Transformation Issues, *Captain Mark Olson,* USN, Chief, ISR & Space Division, United States Strategic Command

Video   Precision Air Drop Screamer

Wednesday, 18 April 2007

Session II: *Integration of Naval Systems*

- The Systems Engineering View of Naval Warfighting Systems Development, *Mr. Carl Siel,* ASN (RDA) Chief Engineer
- The Acquisition Perspective on Development of Naval Open Architectures, *Captain James J. Shannon,* USN, Program Manager for Naval Open Architecture (PEO IWS 7)
- Industry Perspectives on Open Systems Architecture Development for Naval Weapons Systems, *Mr. Robert Riche,* Lockheed Martin
- Open RF System Architectures, *Dr. Bobby Junker,* Office of Naval Research

Session III: *Army Future Combat System (Brigade Combat Team) (FCS(BCT)) Program*

- FCS Program Overview and Challenges, *Brigadier General Tom Cole,* USA

1. Video NLOS-C
2. Video APS
2. Video 120 MCS Cannon
4. Video Common Chassis
5. Video C2V
6. Video AV Class I
7. Video AV Class IV
8. Video SUG V
9. Video Mule 2
10. Video TUGS
11. Video UUGS

12. Video NLOS-LS
13. Video MRM
14. Video NLOS-M
15. Video 07-042 Experiment

- FCS Technology Insertion and Transition Panel

  Panel Moderator: *Dr. Thomas H. Killion*, Deputy Assistant Secretary for Research and Technology/Chief Scientist, HQ Department of the Army

  Panel Members:
  Mr. Paul Rogers, TARDEC
  Mr. Joe Lannon, Director, ARDEC
  Mr. John Miller, Director, ARL

Thursday, 19 April 2007

Session IV: Globalization

- Overview of Global Adaptation of Technology, *Mr. Alan Shaffer*, Director Plans and Programs, ODDR&E
- US Industry Adaptation to Globalization, *Dr. Raj Desai,* IBM, Vice President, Global Aerospace and Defense
- Coalition Partners Adaptation to Globalization, *Dr. Tony Lindsay*, Counsellor, Defence Science, Australian Embassy
- Technical Workforce Issues, *Mr. Edward Swallow, "Work Force Issues",* *"Technical Workforce Issues"*, Vice President, Strategic Capture & Campaigns, Northrop Grumman Information Technology

REVISED AGENDA

NDIA
SCIENCE & ENGINEERING
TECHNOLOGY DIVISION

Presents:
THE 8th ANNUAL
SCIENCE & ENGINEERING
TECHNOLOGY
CONFERENCE/DoD
TECH EXPO

Event #7720
April 17 - 19, 2007

In Cooperation with the Office of the Director of Defense Research and Engineering

The Charleston Convention Center
North Charleston, South Carolina

Tuesday, April 17, 2007

7:30 am Conference Registration & Continental Breakfast

Preliminary Session: Opportunities for Collaboration

In this session we will present the Fiscal Year 2008 President's Budget Request for the Department of Defense S&T program. Specific programs that provide conference attendees opportunities to engage in collaborative efforts with the Department and international S&T community will also be highlighted. Presentations will provide information on technology areas of high interest to the DoD, time lines, and points of contact for the submission of proposals. Opportunities for both industry and academia will be covered. A wide range of programs, from the larger technology demonstrations funded by the Joint Capability Technology Demonstration program, that lead to the evaluation of military utility of advanced technology by a Combatant Commander; to the more focused technology development efforts that are funded by the Test & Evaluation/Science & Technology (T&E/S&T) program will be covered. Opportunities for proposing commercial off-the-shelf technology to meet current military needs will be addressed by the Quick Reaction Fund/Rapid Reaction Fund program presentation. Specific scientific research areas having high interest to the Department will be highlighted along with information on the process universities should use to submit proposals. The session will be rounded out with a presentation on opportunities for collaborative international research and technology development.

Preliminary Session Chairman - Mr. Robert W. Baker, Deputy Director, Plans & Programs, ODDR&E

8:15 am **FY 2008 President's Budget Request for DoD S&T Program**
Mr. Robert Baker, Deputy Director, Plans & Programs, ODDR&E

8:45 am **Joint Capability Technology Demonstration (JCTD) Program**
Mr. John J. Kubricky, Deputy Under Secretary of Defense for Advanced Systems & Concepts

9:15 am **T&E/S&T Program**
Mr. Derrick Hinton, T&E/S&T Program Manager, Defense Test Resource Management Center

9:45 am BREAK

10:30 am **Quick Reaction Fund/Rapid Reaction Fund**
Mr. Ben Riley, Director, Rapid Reaction Technology Office

11:00 am **DoD Basic Research Program with a Focus on Academia**
Dr. William S. Rees, Jr., Deputy Under Secretary of Defense for Laboratories and Basic Sciences

11:30 am **International Collaboration**
Dr. Tony Sinden, Counsellor for Defence Science & Technology, British Embassy

12:00 pm LUNCHEON - EXHIBITS AND POSTER PAPERS OPEN

CONFERENCE OPENING

1:00 pm **Call to Order** - Dr. A. Louis Medin, Chairman, NDIA S&ET Division

NDIA Welcome - Major General Barry D. Bates, USA (Ret), Vice President, Operations, NDIA

1:15 pm **Keynote Address**
Honorable John J. Young, Jr., Director, Defense Research and Engineering

Session I: Air Force Space Systems for Transformation

This session will focus on space systems under development by the Air Force that are important components of transformation in DoD. In particular, key leaders from the areas of Transformational Communications and Responsive Space will describe the ways that technology risk is being handled in these key space programs. Space programs have always provided challenges in balancing performance and risk. Program managers must often select fast-paced technologies to incorporate into space systems that will have operating lifetimes without the opportunity for technology refreshment. Transformational Communications, which will provide enormous increases in networking and capacity for military communications, has exceptional technology and software challenges in developing and acquiring the space, ground, and user segments for a long-life system with advanced networking capability operating in a military environment. Under Responsive Space, the Air Force plans to have small satellites called TacSats that can be launched quickly in response to an urgent need for a space capability. While there are clear opportunities to evolve TacSat capabilities, there are risks in continuing to bring in the latest software and technology. Leaders from the Government programs, the science and technology community, and industry will provide their perspectives on how risk can be mitigated in these challenging areas.

Co-Chairs: Mr. Ed Palo, Chief Engineer, The MITRE Corporation
Mr. Mark Stephen, Director of Strategic Planning, L-3 Coleman Aerospace

2:00 pm **Air Force Space Transformation**
Brigadier General Ellen M. Pawlikowski, USAF, Commander, Military Satellite Communications Systems Wing, USAF Space and Missile Systems Center

2:30 pm **Responsive Space Technology**
Dr. Robert Morris, USAF, Acting Chief Scientist, Air Force Research Laboratory, Space Vehicles Directorate

3:00 pm BREAK IN EXHIBIT HALL

3:45 pm **Program Office Perspective on Transformational Space**
Colonel Rich White, USAF, Director, Developmental Planning, USAF Space and Missile Systems Center

4:15 pm **Industry View and Experience with Responsive Space**
Mr. Stuart Linsky, Vice President, Satellite Communications, Northrop Grumman Space Technology

4:45 pm **User Perspective on Space Transformation Issues**
Captain Mark Olson, USN, Chief, ISR & Space Division, United States Strategic Command

5:30 pm - 7:30 pm RECEPTION IN EXHIBIT HALL

Wednesday, April 18, 2007

7:30 am Conference Registration & Continental Breakfast

Session II: Integration of Naval Systems

The role of systems of systems integrations and interoperability has taken on increasing importance as the emphasis on network centric warfare has evolved and is being implemented in naval warfighting systems. While the Navy has always integrated multiple systems on their ships and aircraft, with the advent of the DDG-1000 Zumwalt Multi-Mission Surface Combatant, Littoral Combat Ship, Multi-Mission Aircraft (MMA) and other network centric platforms, a new dimension of complexity and risk is being added. Now, the ship and aircraft have become the hub into which different combat systems will be rapidly inserted and withdrawn as the operational challenges change. These systems will have to operate upon installation in a plug and play manner without extensive integration testing and grooming. The development and insertion of the software to allow these systems to be responsive to the operator's needs is crucial to the success of the future weapons systems platforms. This session is intended to explore some of the challenges, issues, and solutions associated with reducing the integration, interoperability and software technology risks associated with today's acquisition programs.

Co-Chairs: Mr. Dennis Ryan, Science and Technology Planning Director, John Hopkins University Applied Physics Laboratory
Captain Dennis Sorensen, USN, Assistant Chief of Naval Research, Office of Naval Research

8:30 am **Challenges in Developing and Integrating Naval Warfighting Systems**
Dr. Wayne Meeks, Executive Director, Program Executive Officer, Integrated Warfare Systems (PEO IWS)

9:00 am **The Systems Engineering View of Naval Warfighting Systems Development**
Mr. Carl Siel, ASN (RDA) Chief Engineer

9:30 am **The Acquisition Perspective on Development of Naval Open Architectures**
Captain James J. Shannon, USN, Program Manager for Naval Open Architecture (PEO IWS 7)

10:00 am BREAK EXHIBITS AND POSTER PAPERS OPEN

10:45 am **Industry Perspectives on Open Systems Architecture Development for Naval Weapons Systems**
Mr. Robert Riche, Lockheed Martin
Mr. Richard Rushton, Lockheed Martin

11:15 am **Open RF System Architectures**
Dr. Bobby Junker, Office of Naval Research

12:00 pm LUNCHEON

Luncheon Speaker:
S&T, S&Es and S&SE
Dr. Paul D. Nielsen, Director and CEO, Carnegie Mellon University Software Engineering Institute

Session III: Army Future Combat System (Brigade Combat Team) (FCS(BCT)) Program

The Future Combat Systems (Brigade Combat Team) (FCS (BCT)) Program is the Army's flagship transformation program. FCS (BCT) is the Army's modernization program consisting of a family of manned and unmanned systems, connected by a common network, which enables a modular force, providing soldiers and leaders with leading edge technologies and capabilities. It is a joint (across all the military services) networked (connected via advanced communications) system of systems (one large system made up of 18 individual systems, the network, and most importantly, the soldier) connected via an advanced network architecture that enables levels of joint connectivity, situational awareness and understanding, and synchronized operations. It will operate as a System of Systems (SoS) that will network existing systems, systems already under development, and systems to be developed to meet the requirements of the Army's Future Force. This session will highlight the FCS program as an example of a major acquisition program which is software intensive, and employs various approaches for reducing technology risk. The discussion panel will highlight both technology opportunities and measures used in technology risk reduction.

Co-Chairs:	Dr. Michael Andrews, Vice President & Chief Technology Officer, L-3 Communications Corporation Dr. John Solomond, Program Manager C4ISR, Booz Allen Hamilton, Inc. Dr. Robert Berezdevin, Director, Strategic Programs, SAIC
1:30 pm	**FCS Program Overview and Challenges** Brigadier General Tom Cole, USA Lieutenant General Daniel R. Zanini, USA (Ret), Senior Vice President, SAIC, Deputy Program Manager, FCS Ms. Philomena Zimmerman, Director, Modeling & Simulation Management Office, FCS
2:15 pm	**FCS Software & Distributed Systems** Mr. Edgar L. Dalrymple, PM FCS BCT, Associate Director, Software and Distributed Systems
3:00 pm	BREAK LAST CHANCE TO VIEW EXHIBITS AND POSTER PAPERS
3:45 pm	**FCS Technology Insertion and Transition Panel** **Panel Moderator:** Dr. Thomas H. Killion, Deputy Assistant Secretary for Research and Technology/Chief Scientist, HQ Department of the Army **Panel Members:** Mr. Gary Martin, Director, CERDEC Mr. Paul Rogers, TARDEC Mr. Joe Lannon, Director, ARDEC Mr. John Miller, Director, ARL
5:15 pm	Session Adjourn

Thursday, April 19, 2007

Session IV: Globalization

Over the recent years, globalization has taken on a whole new meaning in the defense industry. It has touched every facet of product life cycle: requirements, design, development, manufacturing, maintenance and repair. In this information age, the whole world appears to be operating without boundaries. Given that the world is becoming flatter by the day, no organization can rely solely on its own resources. This fast pace of globalization offers both opportunities and risks to the DoD in carrying out its mission. In this session, we will address the globalization issues from the perspectives of DoD, US industry and our global partners with special emphasis on ongoing initiatives and lessons learned.

Co-Chairs:	Dr. Raj Aggarwal, Vice President, Global Technology, Rockwell Collins, Inc. Dr. Kenneth Potocki, John Hopkins University Applied Physics Laboratory
8:15 am	**Overview of Global Adaptation of Technology** Mr. Alan Shaffer, Director, Plans and Programs, ODDR&E
8:45 am	**US Industry Adaptation to Globalization** Dr. Raj Desai, IBM, Vice President, Global Aerospace and Defense
9:15 am	**Coalition Partners Adaptation to Globalization** Dr. Tony Lindsay, Counsellor, Defence Science, Australian Embassy
9:45 am	BREAK
10:25 am	**BEST POSTER PAPER WINNER ANNOUNCEMENT**
10:30 am	**DoD Adaptation to Globalization** Mr. Gary Powell, Assistant Deputy Under Secretary of Defense for Industrial Policy
11:00 am	**Technical Workforce Issues** Mr. Edward Swallow, Vice President, Strategic Capture & Campaigns, Northrop Grumman Information Technology
11:30 am	**Wrap Up & Adjourn**
12:00 pm	**BUFFET LUNCHEON**

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Gun and Missile Systems Conference and Exhibition

"Meeting Warfighter Needs for the Asymmetric Threat"

April 23 - 26, 2007

Charlotte, NC

Precision Strike
Annual Programs Review

PRECISION STRIKE ASSOCIATION

April 24 - 25, 2007

Waterford Receptions of Springfield
Springfield, VA

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Joint Service Power Exposition

"Power and Energy Independence for Warfighters"

April 24 - 26, 2007

San Diego, CA

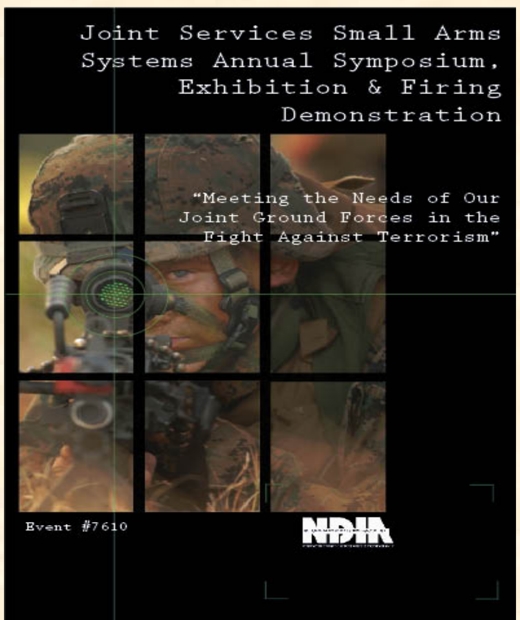
Electromagnetic Launch Conference

INSTITUTE FOR ADVANCED TECHNOLOGY
IAT
aspira ad astra
AUSTIN • TEXAS

May 2 – 4, 2007

Washington, DC

Joint Services Small Arms Annual Symposium, Exhibition and Firing Demonstration



"Meeting the Needs of Our Joint Ground Forces in the Fight Against Terrorism"

May 7 – 10, 2007

Virginia Beach, VA

Defense Systems Acquisition Management Course

May 7 – 11, 2006

Nashville, TN

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Strike, Land Attack, Air Defense Annual Symposium (SLAAD) (SECRET US ONLY)

"Integration and Interoperability with Allies and Coalition Partners in Naval Warfighting "

May 8, 2007

Laurel, MD

CMMI Beyond v1.2 Workshop

May 8 - 11, 2007

San Francisco, CA

Global Demilitarization Conference & Exhibition

May 14 - 17, 2007

Reno, NV

National Small Business Conference

"Critical Infrastructure Opportunities"

May 15 – 17, 2007

Houston, TX

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

2007 Joint Services Environmental Management Conference & Exposition (JSEM)

2007 JSEM

Joint Services Environmental Management and Geospatial Information & Services Conference & Exposition

A Comprehensive Summit on the Evolving World of Environment, Energy, & Geospatial Information within DoD

"A Comprehensive Summit on the Evolving World of Environment, Energy & Geospatial Information within DoD"

May 21 -24, 2007

Columbus, OH

Department of Homeland Security Science & Technology Stakeholders Conference

"A World in Change "

May 21 - 24, 2007

Washington, DC

Fuze Technology Conference

"Changing Fuze Standards"

May 22 – 24, 2006

Nashville, TN

CMMI Beyond v1.2 Workshop

May 22 – 24, 2007

Arlington, VA

Armaments Technology Seminar

"Focus on the Joint Munitions and Lethality Life Cycle Management Command and ARDEC Engineering Issues"

June 11 - 13, 2007

Parsippany, NJ

Expeditionary Warfare Division Wargame

EXPEDITIONARY WARFARE DIVISION

June 13 - 14, 2007

Quantico, VA

Joint CBRN Conference & Exhibition

"Achieving DoD's Full Spectrum Capabilities "

June 25 - 27, 2007

Fort Leonard Wood,
Springfield, MO

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Live Fire Test & Evaluation Conference

"20 Years in Support of the Warfighter"

June 25 - 28, 2007

Goose Creek, SC

NDIA NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Heartland Security Conference & Exhibition

"Technology for Defense and Homeland Security Readiness"

July 9 - 11, 2007

Minneapolis, MN

CMMI Beyond v1.2 Workshop

CMMI® Technology Conference and User Group

July 10 – 13, 2007

Montreal, QC

Defense Systems Acquisition Management Course (DSAM)

July 16 – 20, 2007

Seattle, WA

MDA SBIR Industry Day

July 25 - 26, 2007

Arlington, DC

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Naval S & T Industry Partnership Conference

" Powering the Navy and

Marine Corps After Next "

July 30 – August 2, 2007

Washington, DC

OFFICE OF NAVAL RESEARCH

S&T

ONR

Revolutionary Research . . . Relevant Results

Beyond SBIR Phase II: “Bringing Technological Edge to the Warfighter”

August 20 - 23, 2007

Arlington, VA

NDIA NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Warheads & Ballistics Classified Symposium (Secret US Only)

August 27 – 30, 2007

Monterey, CA

Land & Maritime Supply Chains Business Conference & Exhibition (DSCC)

August 27 - 29, 2007

Columbus, OH

Disruptive Technologies Conference

September 4 - 5, 2007

Washington, DC

Homeland Security Symposium and Exhibition

September 5 - 7, 2007

Arlington, VA

Joint Undersea Warfare Technology Fall Conference (Secret US ONLY)

September 10 - 13, 2007

Groton, CT

Defense Systems Acquisition Management Course (DSAM)

September 10 - 14, 2007

Minneapolis, MN

CMMI Beyond v1.2 Workshop

October 1 - 4, 2007

London, UK

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

Insensitive Munitions/Energetic Material Technology Symposium

"New Programs, New Policies, New Strategies

Leading to New Joint Solutions"

October 15 - 18, 2007

Miami, FL

Joint Chemical Biological Collective Protection/Decontamination/Individual Protection Conference and Exhibition

October 22 - 24, 2007

Virginia Beach, VA

2007 Combat Vehicles Conference

October 22 - 24, 2007

Dearborn, MI

10th Annual Systems Engineering Conference

October 22 - 25, 2007

San Diego, CA

Expeditionary Warfare Conference

EWD
EXPEDITIONARY WARFARE DIVISION

October 22 - 25, 2007

Panama City, FL

Tank-Automotive Command Life Cycle Management Command Advance Planning Briefing for Industry

October 24 - 26, 2007

Dearborn, MI

2007 USCG Innovation EXPO

"U.S. Coast Guard Innovation: Improving

Mission Execution and Sustainment "

October 28 – November 1, 2007

New Orleans, LA

Targets, UAVs & Range Operations Symposium & Exhibition

October 29 - 31, 2007

San Diego, CA

7th Annual CMMI® Technology Conference and User Group

November 12 - 15, 2007

Denver, CO

Globalization of Technology Impact on US Military

Mr. Alan Shaffer

Director, Plans & Programs, ODDR&E

April 19, 2007

Some Opening Thoughts

- ***In times of change, learners inherit the Earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists”***

  Eric Hoffer

- ***The future has a way of arriving unannounced***

  George Will

- ***Research is what I am doing when I don’t know what I am doing***

  Werner Von Braun

- ***There is no reason anyone would want a computer in their home***

  Ken Olson, President, DEC, 1977

- ***Everything that can be invented has been invented***

  Charles Duell, Commissioner US Patent Office,1899

- ***If you don’t know where you are going, you might end up someplace else***

  Yogi Berra

Shocks from the Past Century

Categories of trends
- Conflict
- Demographics
- Economy
- Environment
- Governance
- Science & Technology
- *Note: Size of circle indicates impact*

❑ Strategic shocks can change how we think about security and the role of the military, e.g.:

Implications for:

	1929	1941	1945-1955	1957	1989-1991	2001	2005
	Great Depression	Pearl Harbor	Atomic Revolution	Sputnik	Fall of the Soviet Union	9/11 Attacks	Katrina
Military	• Reduced role of military in society	• Led to two-front war; Made intelligence a core element of operations	• Nuclear warfare and capability become primary military mission	• Space as a military domain	• Led to the drawdown of the U.S. military – shifted focus to peace-keeping missions	• Made homeland defense and irregular warfare central military missions	• Increased military role in managing domestic catastrophes
Security	• Reinforced isolationist tendencies in the U.S.	• Recognition of vulnerability – led to international engagement and industrialization for war on home front	• Emergence of MAD and escalation management	• Space leveraged for national power and prestige	• End of bipolar world	• Redefined security for the American public – CT emerges as USG focus	• American public looks to the federal, rather than local, government for disaster relief

Cold War (Atomic Revolution – Fall of the Soviet Union)

In retrospect, these shocks were the product of long-term trends

FROM OUSD (Policy) – Future Shocks Study

Technology and the Modern World

- ***"The conjunction of 21st century internet speed and 12th century fanaticism has turned our world into a tinderbox"***

  Tina Brown ,Washington Post, 19 May 2005

- ***"The challenge of the defense planner and strategist is not to avoid being surprised. Rather, it is to plan against some of the more dire potential effects of surprise…'."***

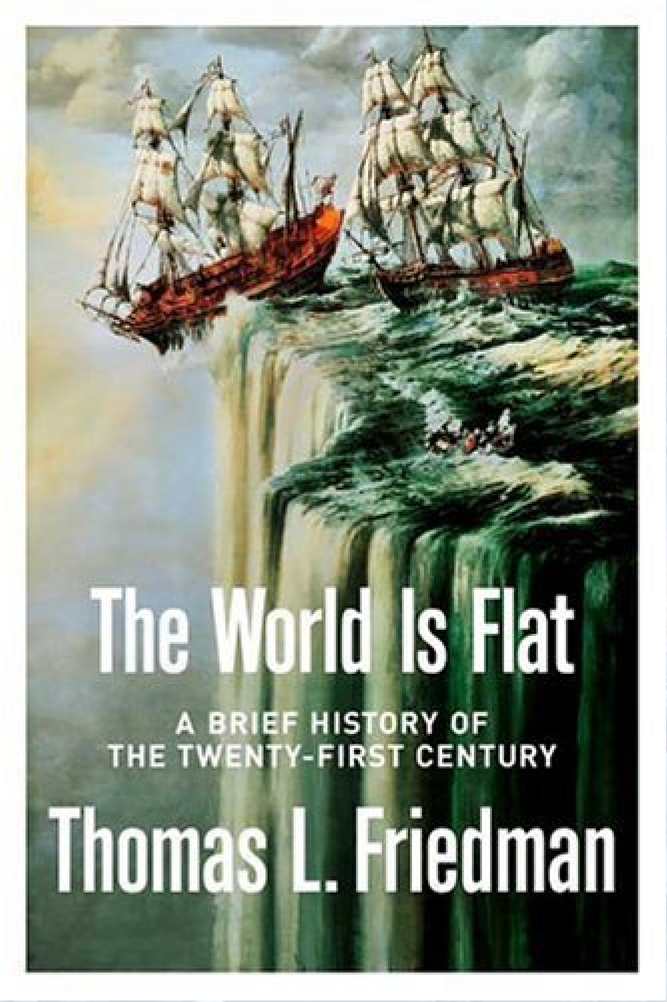
  Colin Gray, Transformation and Strategic Surprise

- ***"It is this convergence -- of new players, on a new playing field, developing new processes for horizontal collaboration -- that I believe is the most important force shaping global economics and politics in the early 21st century. Sure, not all three billion can collaborate and compete…but even if we're talking about only 10 percent, that's 300 million people -- about twice the size of the American work force. And be advised: the Indians and Chinese are not racing us to the bottom. They are racing us to the top."***

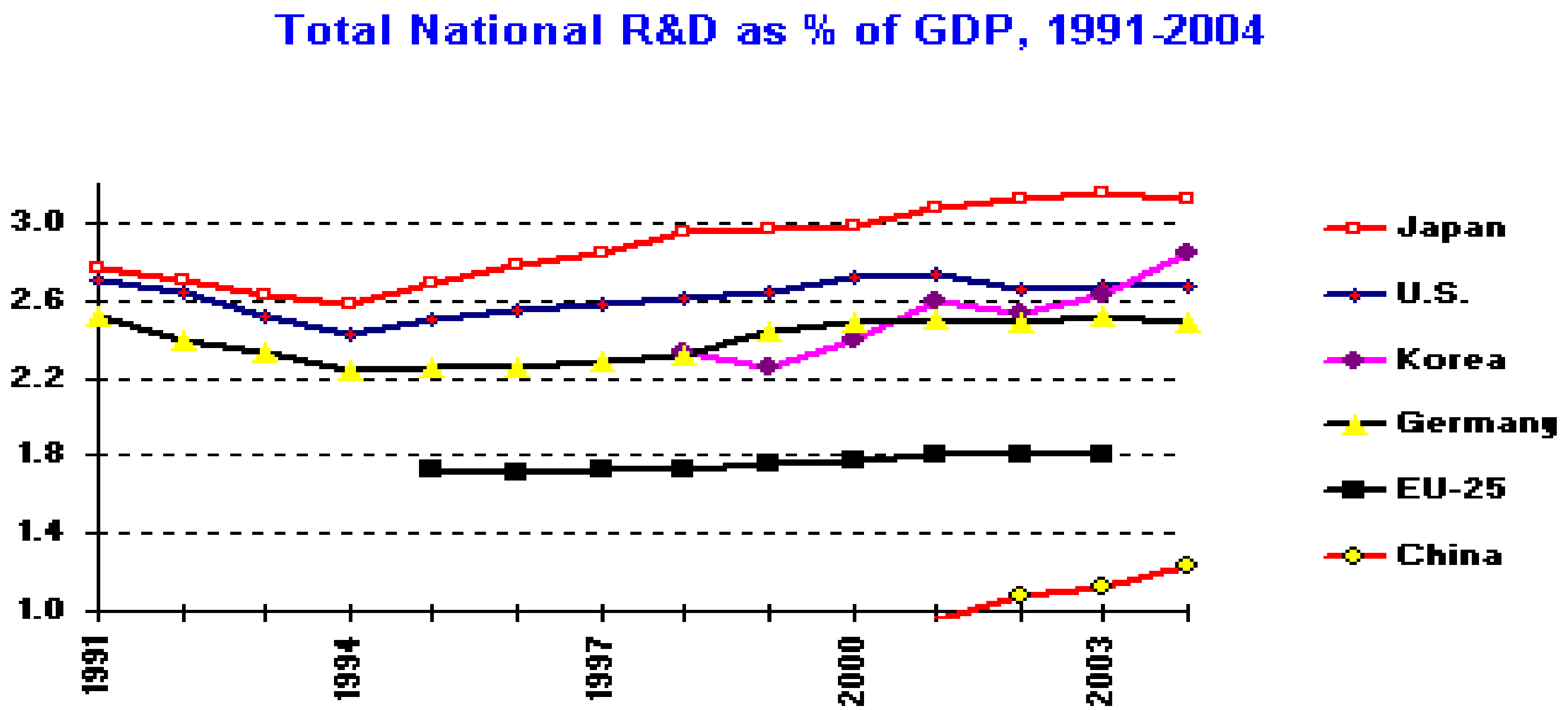
  Thomas Friedman, The World is Flat

Overview

- **Global Technology Development Trends**
- **Technology Case Studies: Past, Present and Future**
- **Quadrennial Defense Review**



National R&D Funding Levels

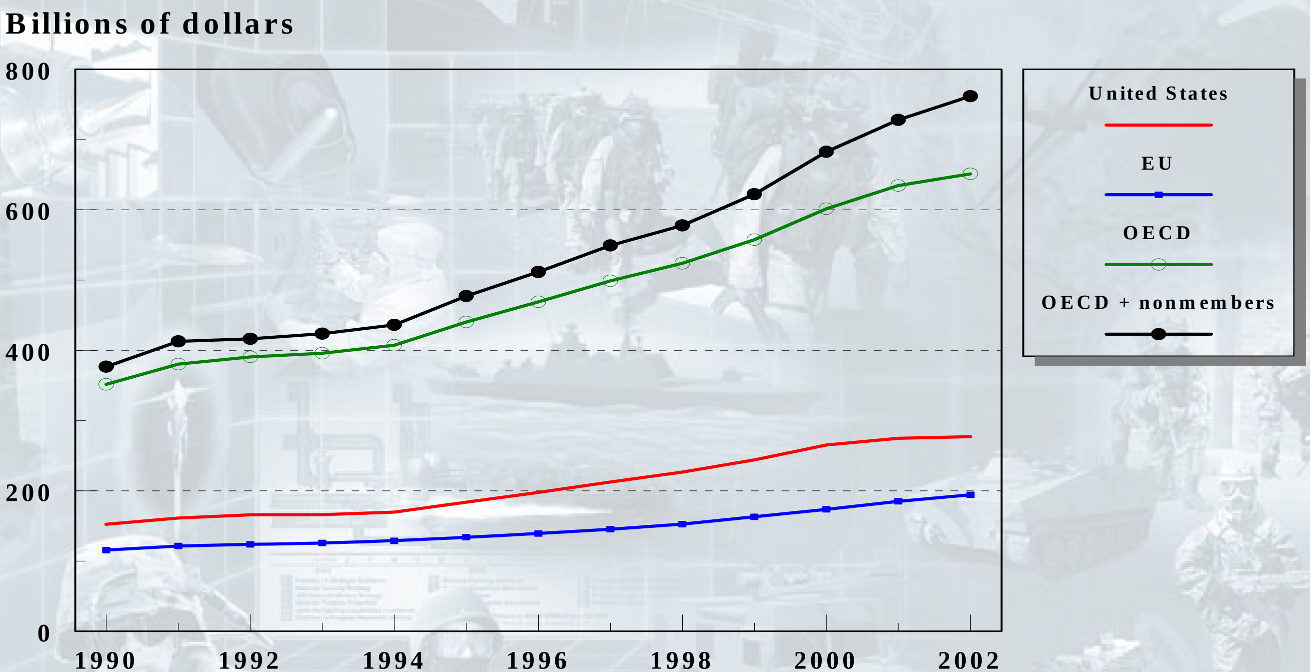


Source: National Science Foundation, National Patterns of R&D Resources and OECD, Main Science and Technology Indicators. Data not available for all nations for all years. SEPTEMBER '06 © 2006 AAAS

International R&D trends

- **R&D expenditures are increasing robustly around the world, driven by both governments and industry.**

Figure 1. Estimated worldwide R&D expenditures: 1990-2002



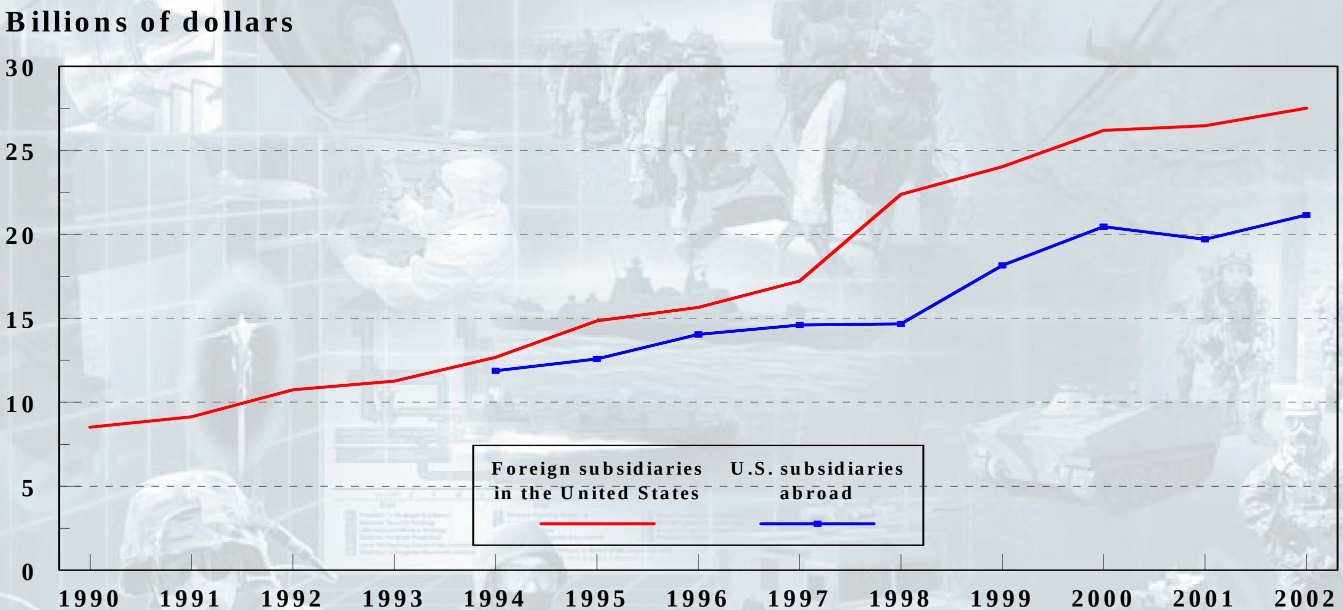
NOTE: Billions of current dollars converted with purchasing power parities.
EU data since 1998 include 10 new member countries.
SOURCE: OECD, Main Science and Technology Indicators database, November 2004

Source: National Science Foundation, S&E Indicators 2006

Internationalization of R&D

- **Firms' cross-border R&D investments are on the increase.**

Figure 3. R&D expenditures of foreign-owned firms in the United States and of U.S.-owned firms abroad: 1990-2002



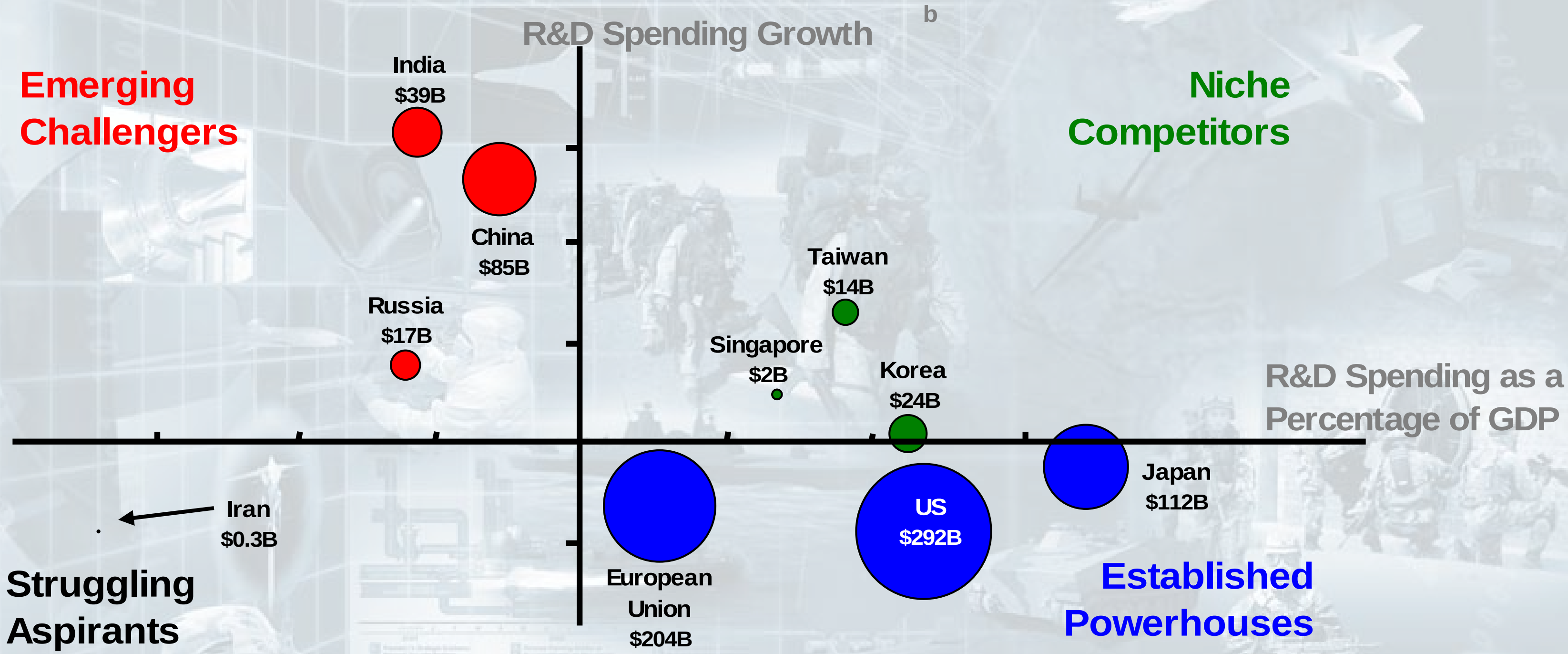
SOURCE: U.S. Department of Commerce, BEA, Surveys of Foreign Direct Investment in the United States and U.S. Direct Investment Abroad; and National Science Board, Science & Engineering Indicators 2006, appendix tables 4-49 and 4-51.

Source: National Science Foundation, S&E Indicators 2006

Global Technology (R&D) Spending and Growth

The R&D Spending Landscape - Selected Entities[a]

(Circle size reflects R&D spending levels.)



[a]R&D spending as a percentage of GDP and spending growth are defined in Figures 1 through 3. R&D spending levels are in current billions of PPP dollars.

[b]Growth rates are calculated since 2000, except for Russia, which was calculated since 1992 due to high uncertainty in the regression since 2000.

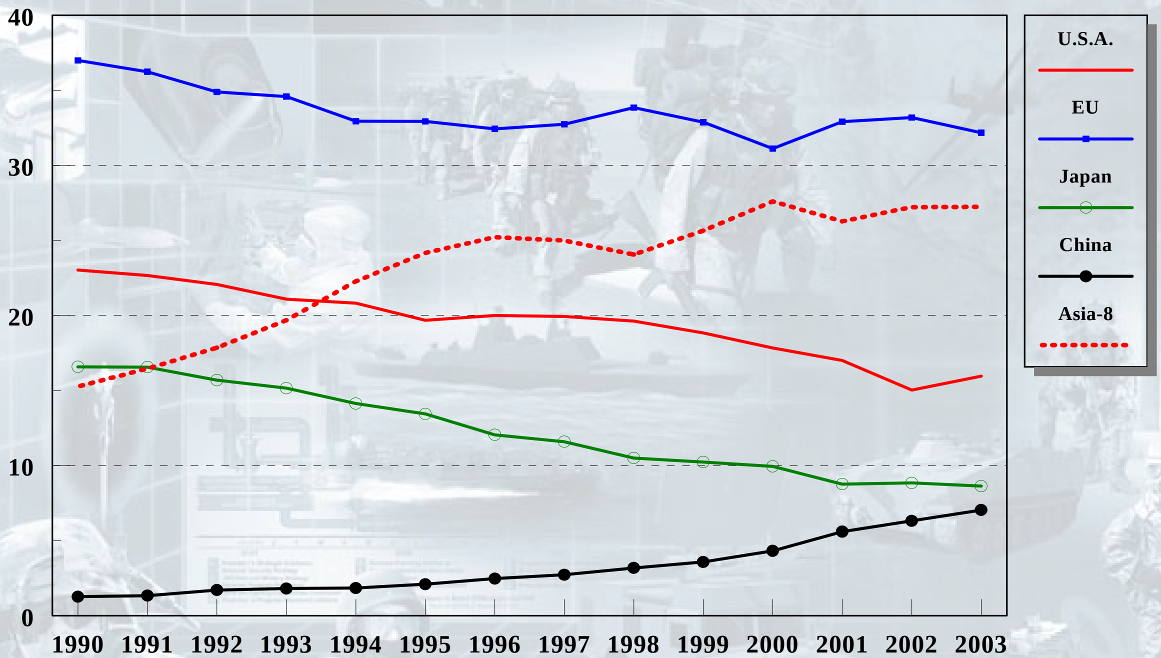
Sources: OECD, Main Science and Technology Indicators Volume 2005; UNESCO, Science Report 2005; Indian Ministry of Science and Technology, Science and Technology Annual Report 2004-2005; H. Arfaei, "Status of Scientific Research -- Iran 2005", April 2005; CIA World Fact Books, 1981-1990, 1997- 2004; and World Bank, Development Indicators database, 1981-1990, 1997-2004.

High technology exports

- High technology exports are expanding, but European, Japanese, and U.S. export shares are shrinking as those of China and other Asian exporters are rising.

Figure 11. Export market shares in high technology goods: 1990-2003

Percent



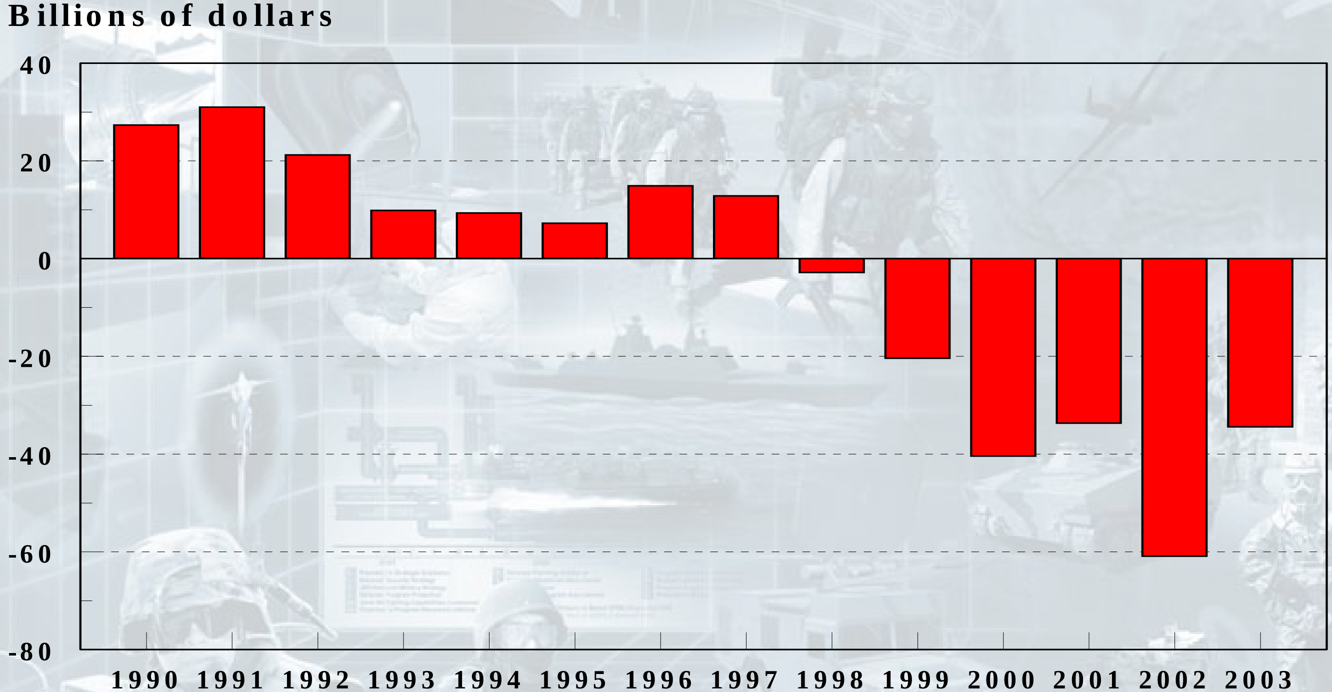
NOTE: Asia-8 includes South Korea, India, Indonesia, Malaysia, Philippines, Singapore, Taiwan, and Thailand.
SOURCE: Global Insight and S&E Indicators 2006

Source: National Science Foundation, S&E Indicators 2006

U.S. trade balance – high tech industries

- **The trade balance of U.S. high technology industries has turned negative**

Figure 12. U.S. trade balance for five high technology industries: 1990-2003

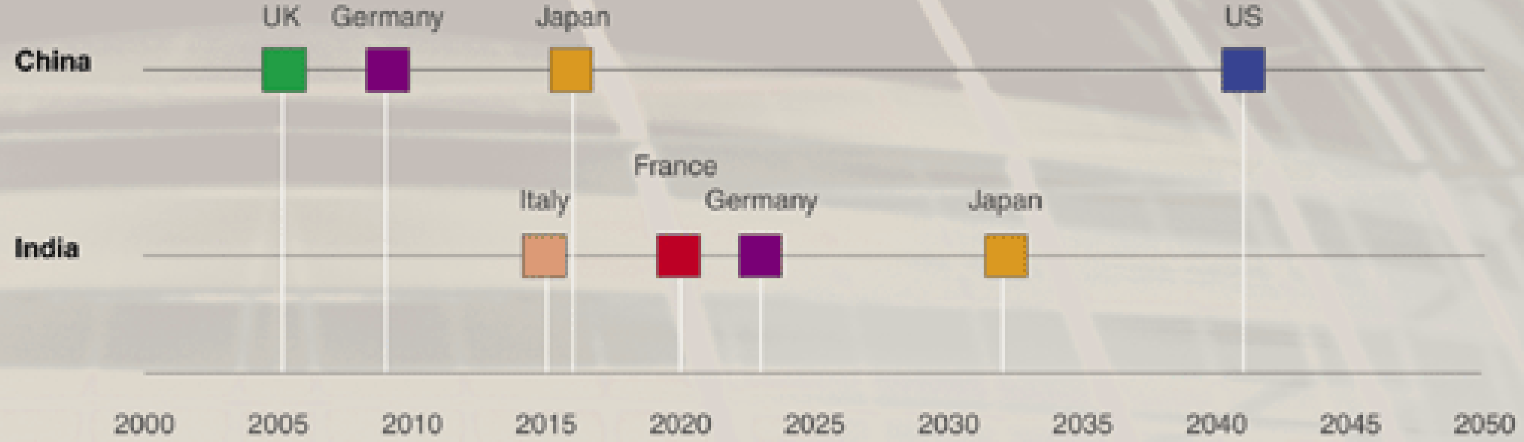


NOTE: Includes aerospace; pharmaceuticals; office and computing equipment; communication equipment; and scientific instruments.
SOURCE: Global Insight and S&E Indicators 2006

Source: National Science Foundation, S&E Indicators 2006

Rising Powers: The Changing Geopolitical Landscape

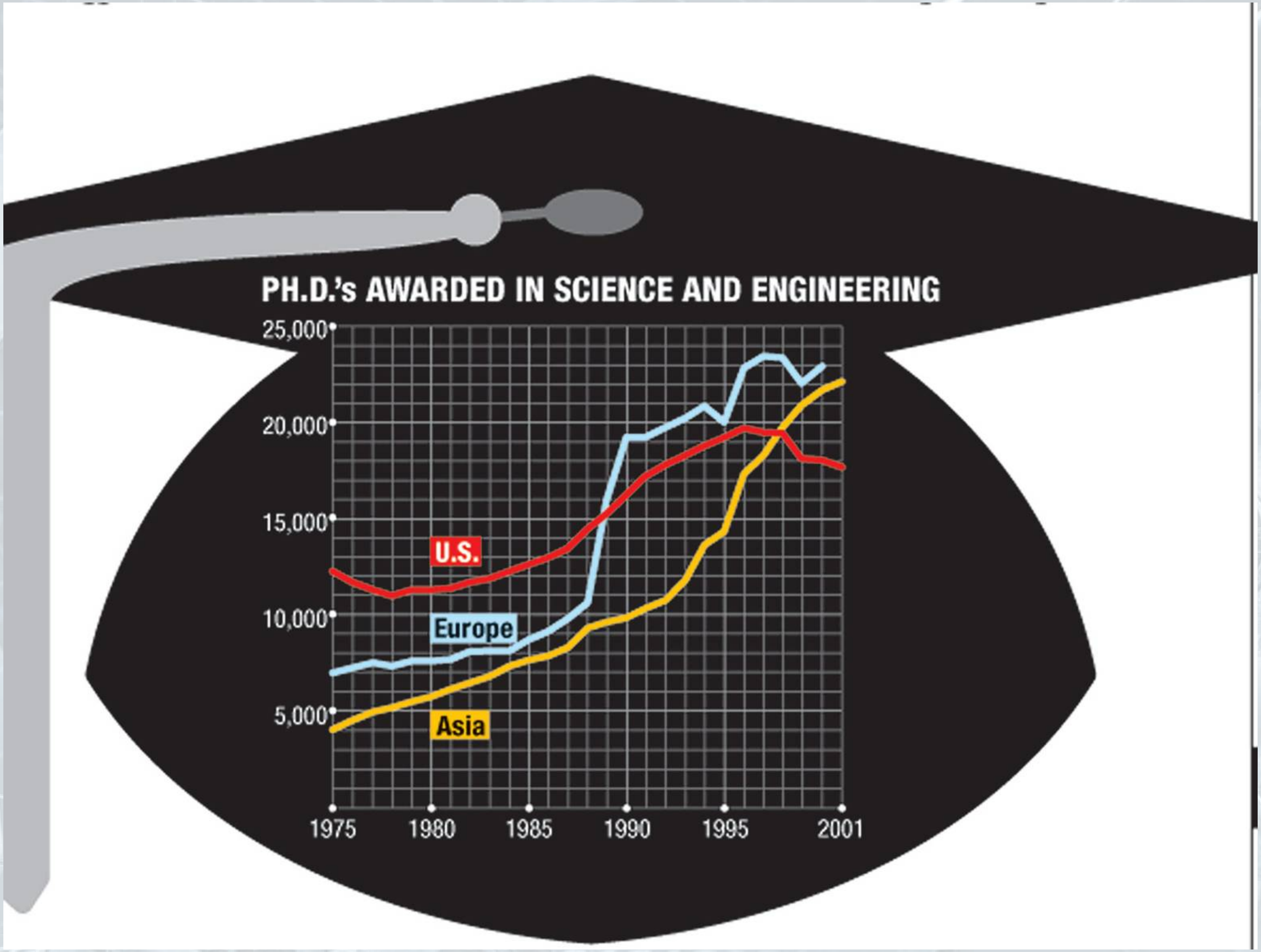
When China's and India's GDPs Would Exceed Today's Rich Countries



Globalization Changes Everything

Source: Goldman Sachs, *Global Economics Paper No: 99*, October 2003.

Comparison of Scientists & Engineers (S&Es)

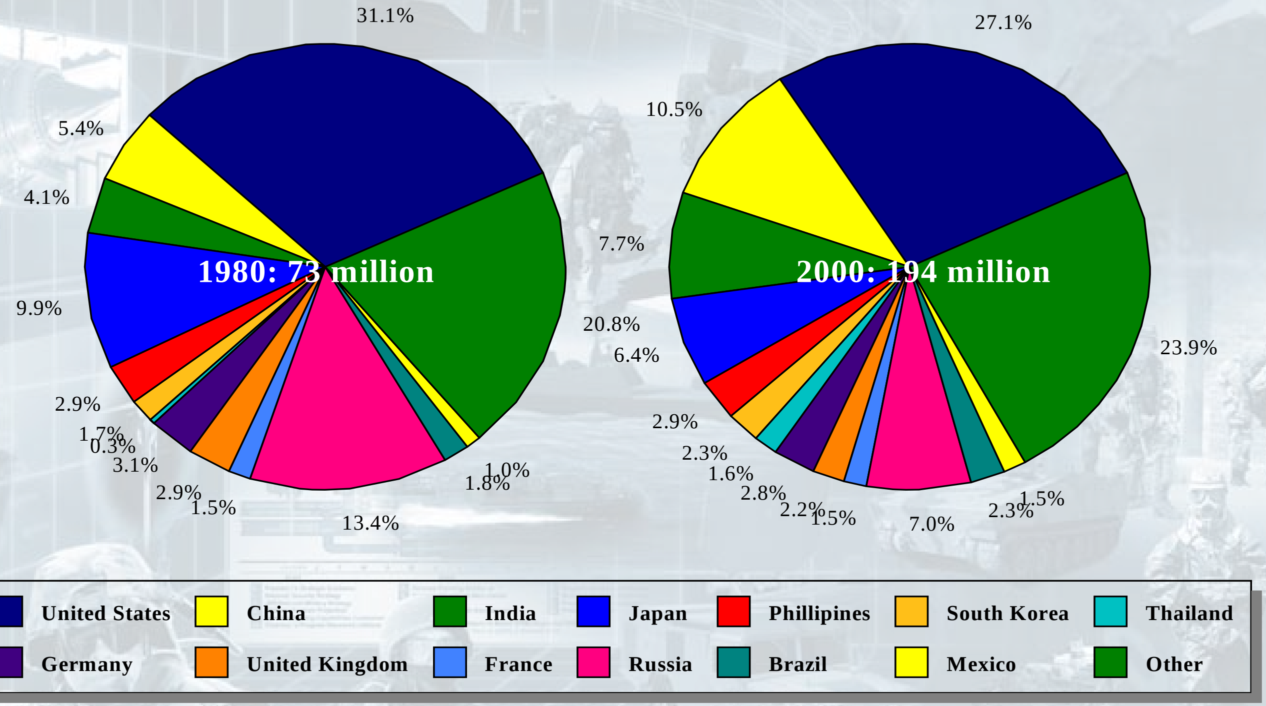


Source: Money Magazine: 2005

Growth of educated Asian population

- International S&E labor force data can only be approximated.

Figure 20. Population 15 years and older with tertiary education, by country/region: 1980, 2000



SOURCE: Adapted from R.J. Barrow and and J. Lee, Center for International Development: International Data on Educational Attainment, 2000

Source: National Science Foundation, S&E Indicators 2006

Trends

- **Increasing**
  - **International Science and Technology Relative to the US**
  - **Industrial Globalization of R&D**
  - **Pace of Technology Development**
  - **US Trade Balance in High-Tech Goods**
- **Decreasing**
  - **US Production of Global Scientists and Engineers relative to World**

US High Technology Advantage not Assured

Competition Increasing

Therefore, Have to Work on "High Payoff" Areas

Overview

- **Global Technology Development Trends**
- **Technology Case Studies: Past, Present and Future**
  - **Rand 2006**
  - **Office of Secretary of Defense (Policy) Future Shocks**
- **Quadrennial Defense Review**

You never got the hang of the new technology, did you Miss Faversham?

2006 Rand Study
The Global Technology Revolution

- **Not a DoD Study, but a Study of the Future Technology “Shocks”**
- **Looked at Technology Growth, Needs and Opportunities**
- **Assessed Which Nations are Poised to Adapt, Lead**

2006 RAND Study*: Top 16 Technology Applications

Need to understand the second-order effects of emergent technologies on the DoD

- ⇒ **Cheap solar energy**
- ⇒ **Rural wireless communications**
- ✓ **Communication devices for ubiquitous information access anywhere, anytime**
- • **Genetically modified (GM) crops**
- ⇒ **Rapid bioassays**
- ⇒ **Filters and catalysts for water purification and decontamination**
- ⇒ **Targeted drug delivery**
- • **Green manufacturing**
- ✓ **Ubiquitous RFID tagging of commercial products and individuals**
- ⇒ **Hybrid vehicles**
- ✓ **Pervasive sensors**
- ⇒ **Tissue engineering**
- ⇒ **Improved diagnostic and surgical methods**
- ⇒ **Wearable computers**
- ✓ **Quantum cryptography**
- • **Cheap autonomous housing**

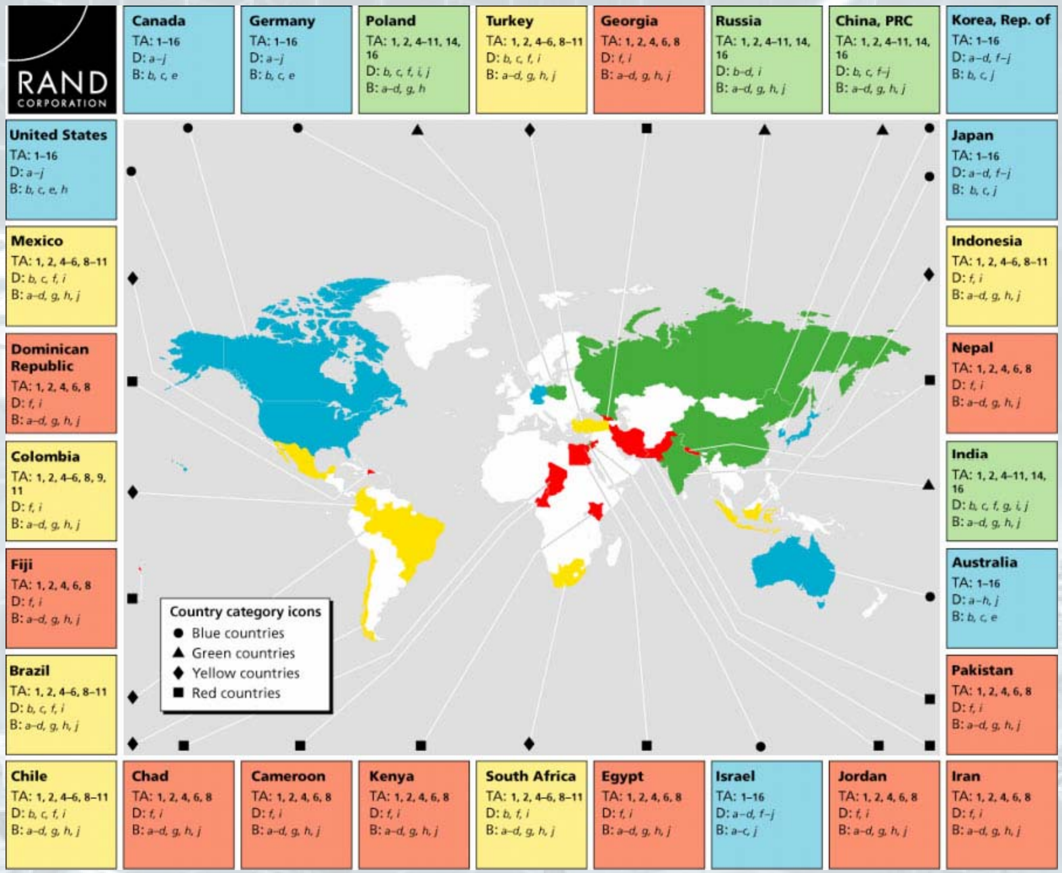
✓ *Direct Military Application*

⇒ *Indirect Military Application*

• *No Military Application*

** The Global Technology Revolution 2020, In-Depth Analyses*

Selected Countries Capacity to *Acquire* the Top 16 Technology Applications*



Scientifically advanced

Scientifically proficient

Scientifically developing

Scientifically lagging

****The Global Technology Revolution 2020, In-Depth Analyses***

OUSD(Policy): Strategic Futures Effort

- Assess the defense implications of long-term "trends" and potential "strategic shocks" to:
  - Generate defense strategies to <u>shape</u> the strategic environment over the next two decades.
  - Predispose the national security establishment toward defense strategies that can help us <u>hedge</u> against a range of plausible alternative futures

Generate forward-looking proposals for changes in the roles, mission, and capability needs of the military

Initial Findings: DoD Future Technology Shocks Study

- ***Held at Irvine Ca, Nov 2006***

- ***The Most Probable Future Technology Shocks areas are:***

Biotechnology

Nanotechnology

Information Technology

Potential Military Applications:

Biotechnology	Nanotechnology	Information Technology
- High Energy Fuels	- Advanced Materials	- Assisted Decision Making
- Bio-based Computers	- Energy Storage / Distribution	- Aided Target Recognition

Genomics: Development Timeline

US Bio-Tech Science & Technology Good

Genetic Engineering and Research Applications Very Strong in Europe, Korea, Singapore…

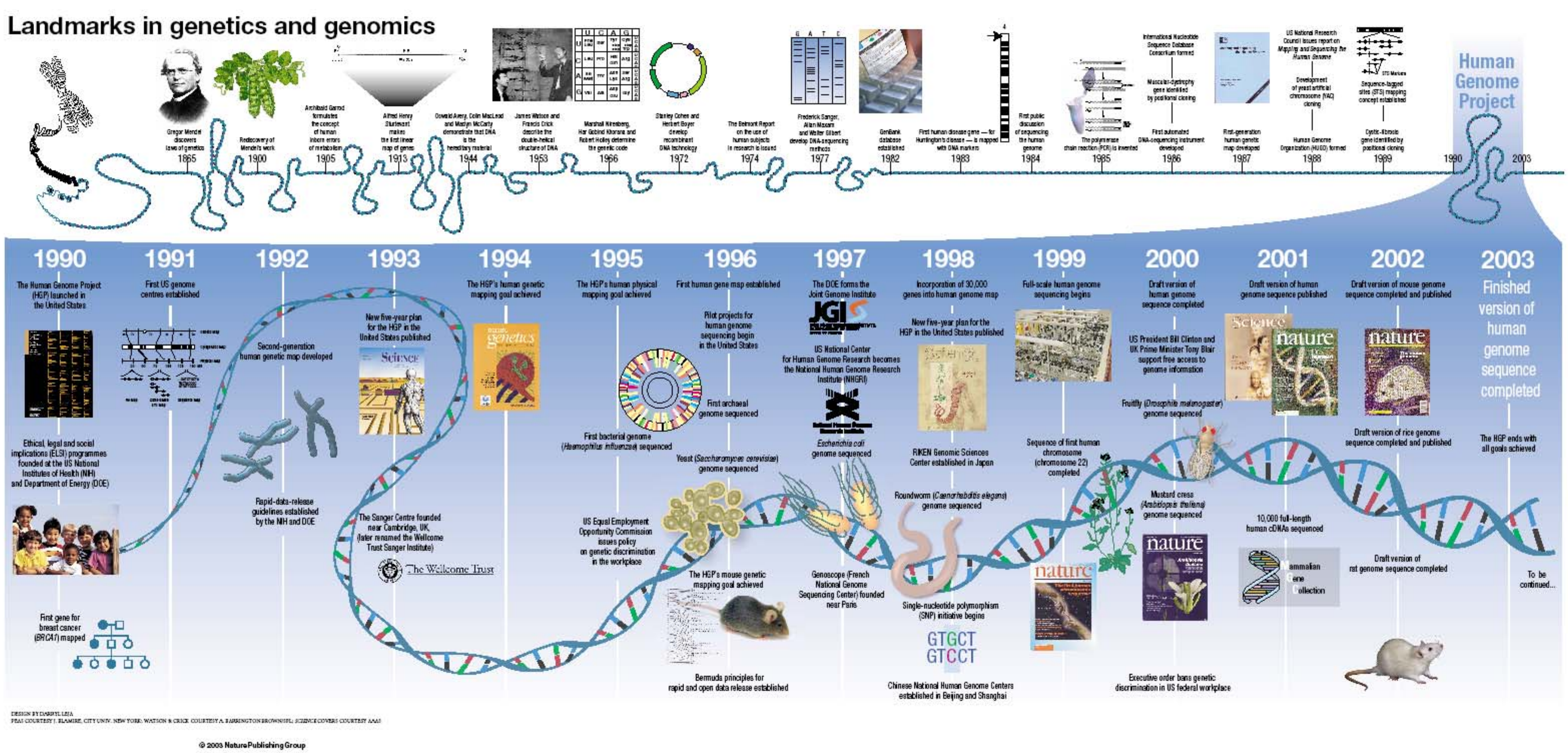
1865: Gregor Mendel discovers laws of genetics

1953: Double-helical structure of DNA described

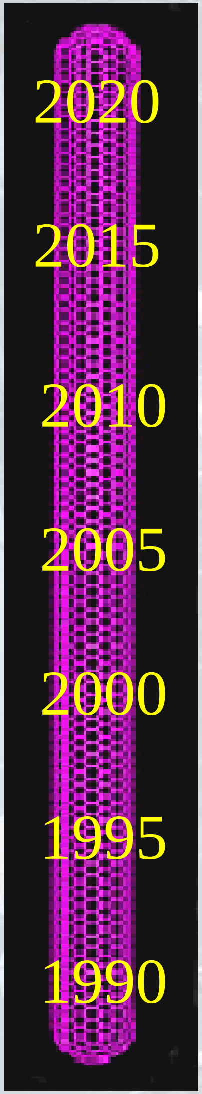
1984: First public discussion of mapping the human genome

1988: Human Genome Organization formed

2003: Human Genome Project completed



Nanotube Timeline Projection



- Molecular electronics, NEMS, Composite materials
- Textiles, CBR filters, biomedical
- Batteries, fuel cells, H_2 storage, ultra-capacitors, RAM, MEMS, microelectronics, FED

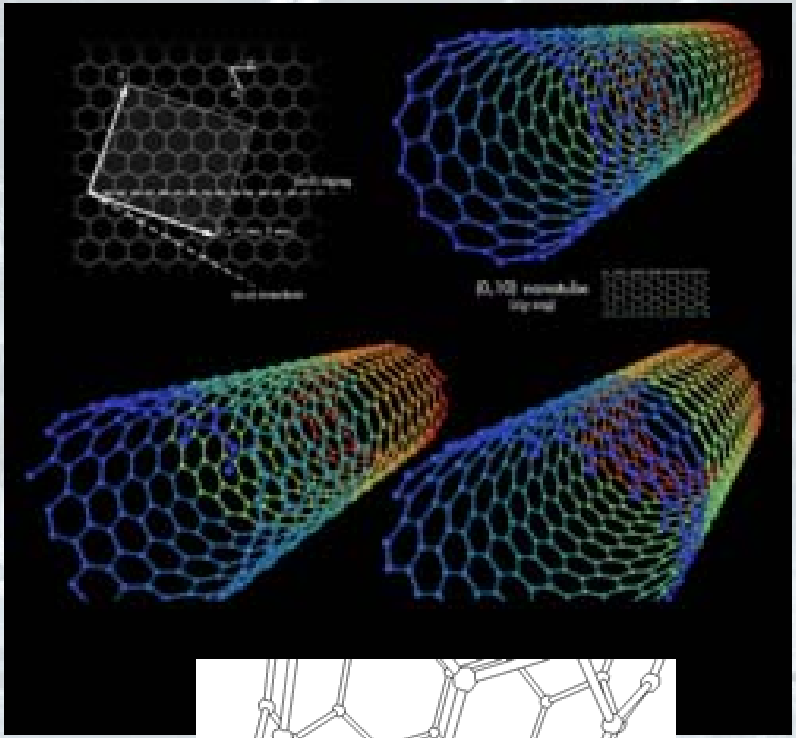
- ✸ Volume Production MWNT (SWNT?)
- ✓ Japanese pilot plant: 100 g/hr (MWNT)
- ✓ Netherlands – nanotube transistor concept
- ✓ Chinese – 3mm long nanotube
- ✓ Experimental demo - H_2 storage, FED

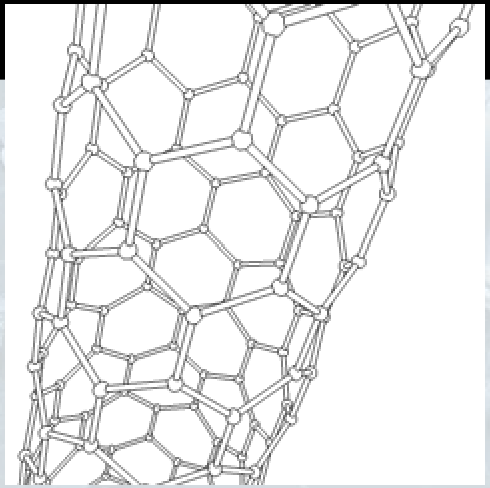
- ✓ Japanese discovery (1991)

Nanotechnology – Rapid Technology Evolution/Application Cycle

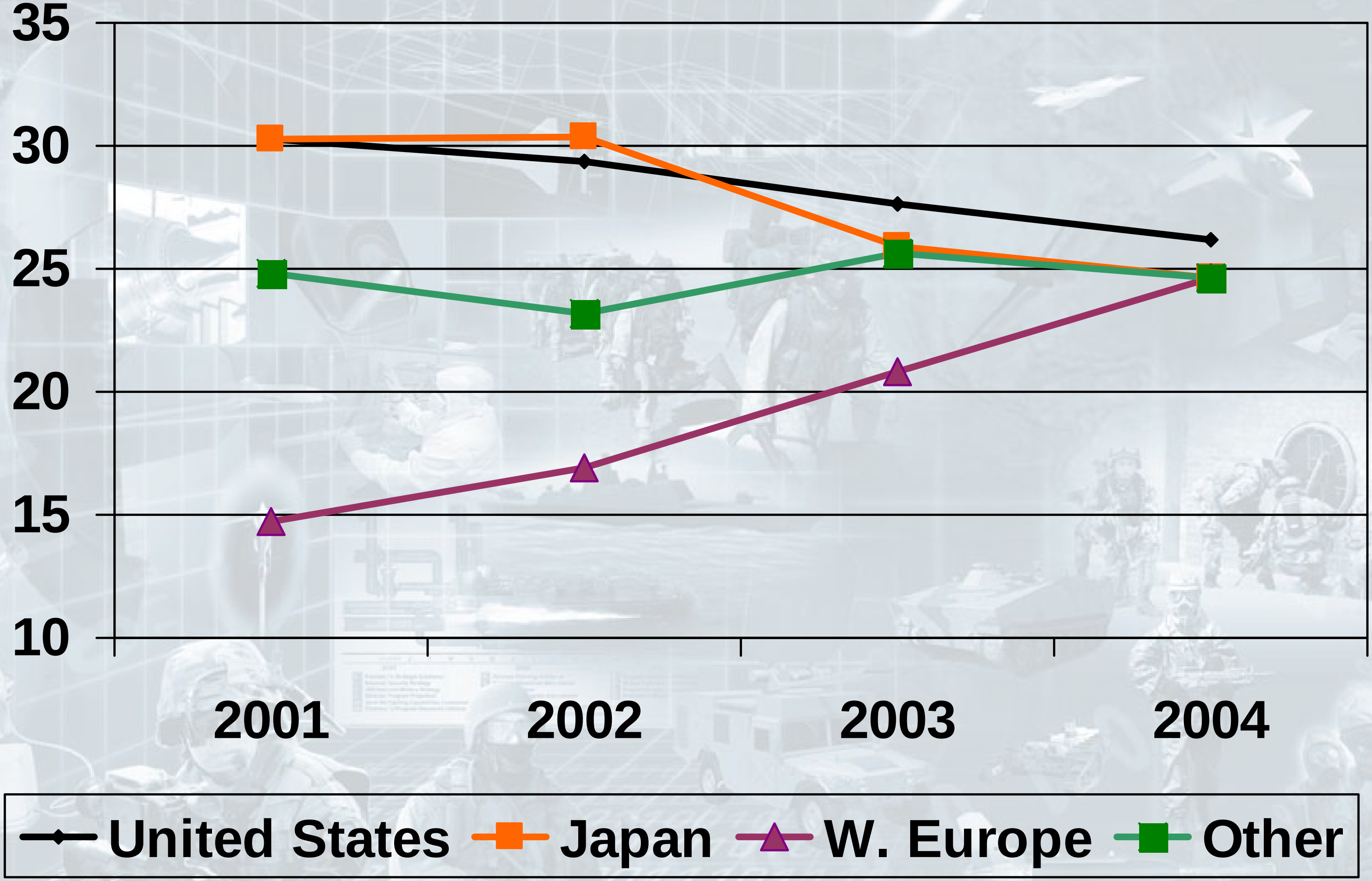
- **The carbon nanotube—was discovered by Sumio Iijima (Japan) in 1991**
  - **1995, researchers recognized carbon nanotubes were excellent sources of field-emitted electrons**
  - **By 2000, the “jumbotron lamp,” a nanotube-based light source was available as a commercial product**

- **By contrast, the period of time between the modeling of the semiconducting property of germanium in 1931 and the first commercial product (the transistor radio) was 23 years.**





Nanotechnology World Investment (%)



Source: Sean Murdock, Testimony before the Research Subcommittee of US, June 29, 2005

The Communication Revolution

--The Pace of IT Development is Accelerating--

- **Fifteen years ago, only scientists were using (or had even heard about) the Internet, the World Wide Web was not up and running….**

- **Twenty years ago the use of desktop personal computers was still limited to a fairly small number of technologically advanced people. The overwhelming majority of people still produced documents with typewriters….**

- **Fifteen years ago, large and bulky mobile telephones were carried only by a small number of users in just a few U.S. cities…..**

…… *And these technologies are not the domain of a few countries*

Globalization 101.org website

Overview

- Global Technology Development Trends

- Technology Case Studies: Past, Present and Future

- Quadrennial Defense Review
  - Change in DoD Strategic Framework
  - Implications for DoD Technology

QDR Priority Formulation

- Balanced what the US wants to protect against (Strategic Challenges) and outcomes the US wishes to accomplish (Strategic Outcomes)

  - Strategic Challenges
    - Traditional
    - Irregular Warfare
    - Combating WMD
    - Disruptive

  - Strategic Outcomes

    - Defeat Terrorist Networks
    - Defend the Homeland in-Depth
    - Shape Choices of Countries at Strategic Crossroads
    - Prevent the Use of WMD

QDR In A Banner – A Shift in Emphasis from "Kinetic" to "Non-Kinetic" Systems

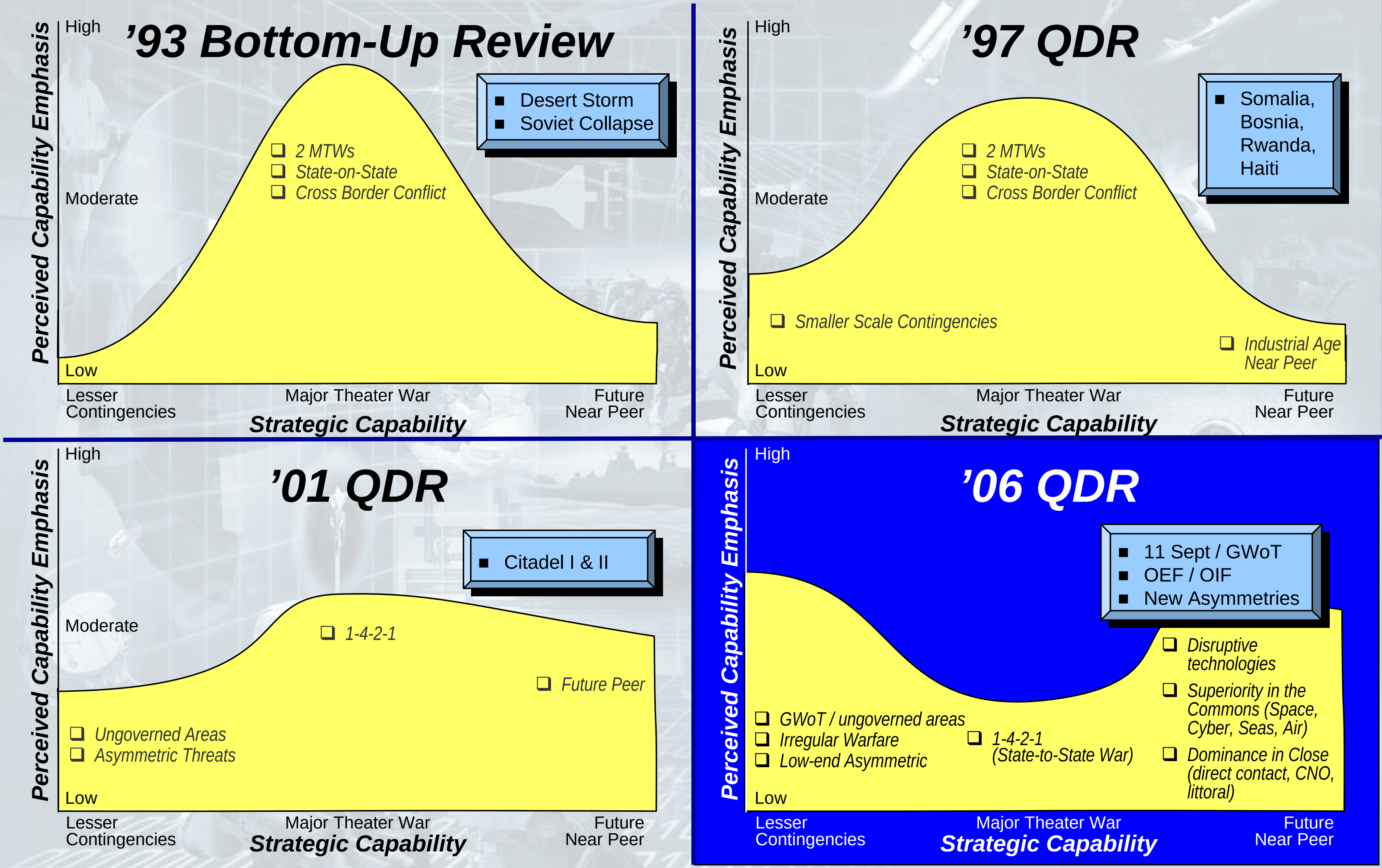
Science and Technology Enabling Technology Priorities

- **Potential technology focus areas:**
  - **Biometrics and Biological exploitation**
  - **Information technology and applications**
  - **Persistent Surveillance Technology**
  - **Networks and Communication**
  - **Human, Social, Cultural, and Behavioral Modeling**
  - **Language**
  - **Cognitive Enhancement**
  - **Directed Energy**
  - **Autonomous systems**
  - **Hyperspectral sensors**
  - **Nanotechnology**
  - **Advanced Materials**
  - **Energy and Power**
  - **Affordability**
  - **Combating Weapons of Mass Destruction Technologies**
  - **Energetic Materials**

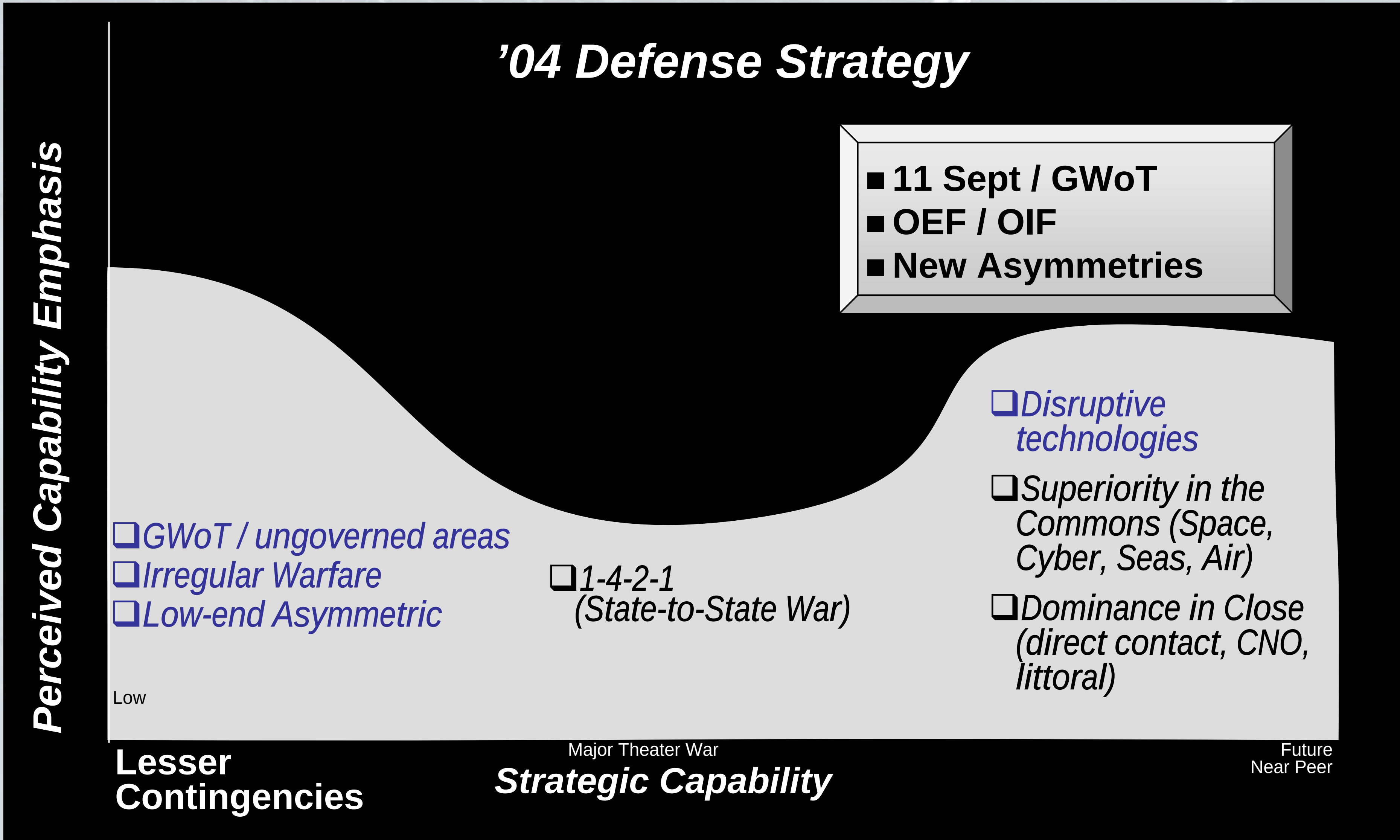
Summary

- Rest of world is getting smarter and the rate of technology change is increasing
- Entire US technical structure needs to work closely, as a team
- More Needs for System Engineering
- Need exists to stretch conventional wisdom
- DoD technical efforts migrating for new US strategic framework

Decade of Strategic Evolution



Decade of Strategic Evolution



Capabilities to Defeat Terrorist Networks

- Persistent surveillance
- Locate, tag, and track terrorists in denied areas
- Capabilities to fuse intelligence
- Language and cultural awareness
- Non-lethal capabilities
- Joint coordination, processes and systems

Non-kinetic capabilities

- Urban warfare capabilities
- Prompt global strike
- Riverine warfare capabilities

Kinetic Capabilities

All These Capabilities are Joint, Coalition Centric

Capabilities to Defend the Homeland In Depth

- **Interoperable, joint command and control**
- **Enhanced air and maritime awareness**
- **Consequence management**
- **Broad spectrum medical countermeasures**

Non-kinetic capabilities

All These Capabilities are Joint, Coalition Centric

Capabilities to Prevent the use of Weapons of Mass Destruction

- **Locate, tag, track, and characterize**
- **Stand off fissile material detection**
- **Wide area persistent surveillance**
- **Capabilities to "render safe" WMD**
- **Non-lethal weapons**

Non-kinetic capabilities

All These Capabilities are Joint, Coalition Centric

Capabilities to Shape the Choices of Countries at Strategic Crossroads

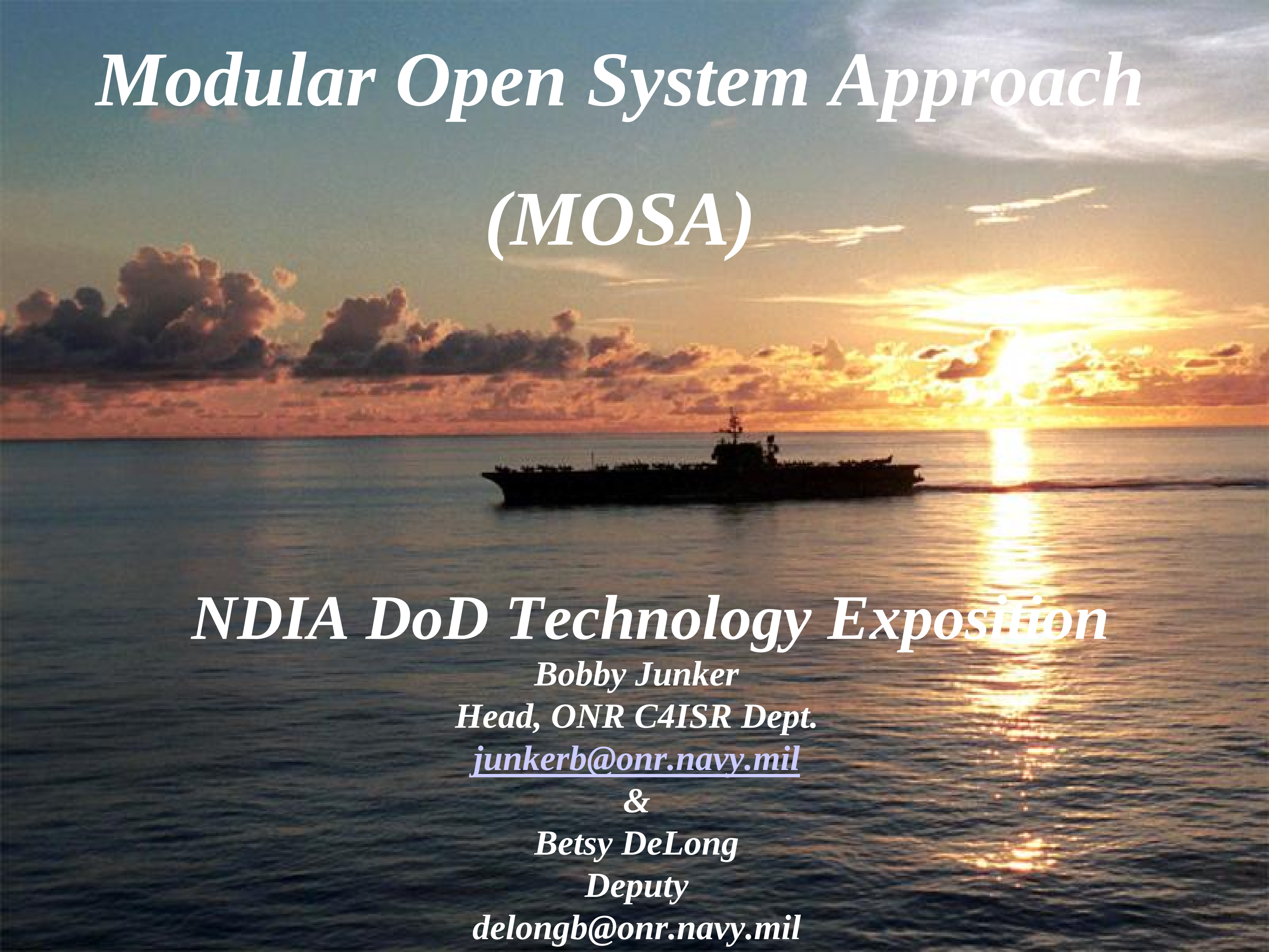
- Improved language and cultural awareness
- Persistent surveillance (penetrate and loiter)
- Cyberspace shaping / defense
- Secure broadband communications
- Integrated defense against all missiles

Non-kinetic capabilites

- Prompt, high-value global strike
- Air dominance
- Undersea stealth

Kinetic

Most of These Capabilities are Joint, Coalition Centric



Modular Open System Approach (MOSA)

NDIA DoD Technology Exposition

Bobby Junker
Head, ONR C4ISR Dept.
junkerb@onr.navy.mil
&
Betsy DeLong
Deputy
delongb@onr.navy.mil

Modular Open Systems Approach

- An integrated business and technical strategy that employs a modular design and defines key interfaces using widely supported, consensus-based standards that are published.
- Modular open architecture approach enables an acquisition strategy where:
  - Components may be acquired from multiple sources
  - Total system can be provided by multiple vendors
  - Multiple vendors may provide the replacement parts across the system over life cycle including upgrades

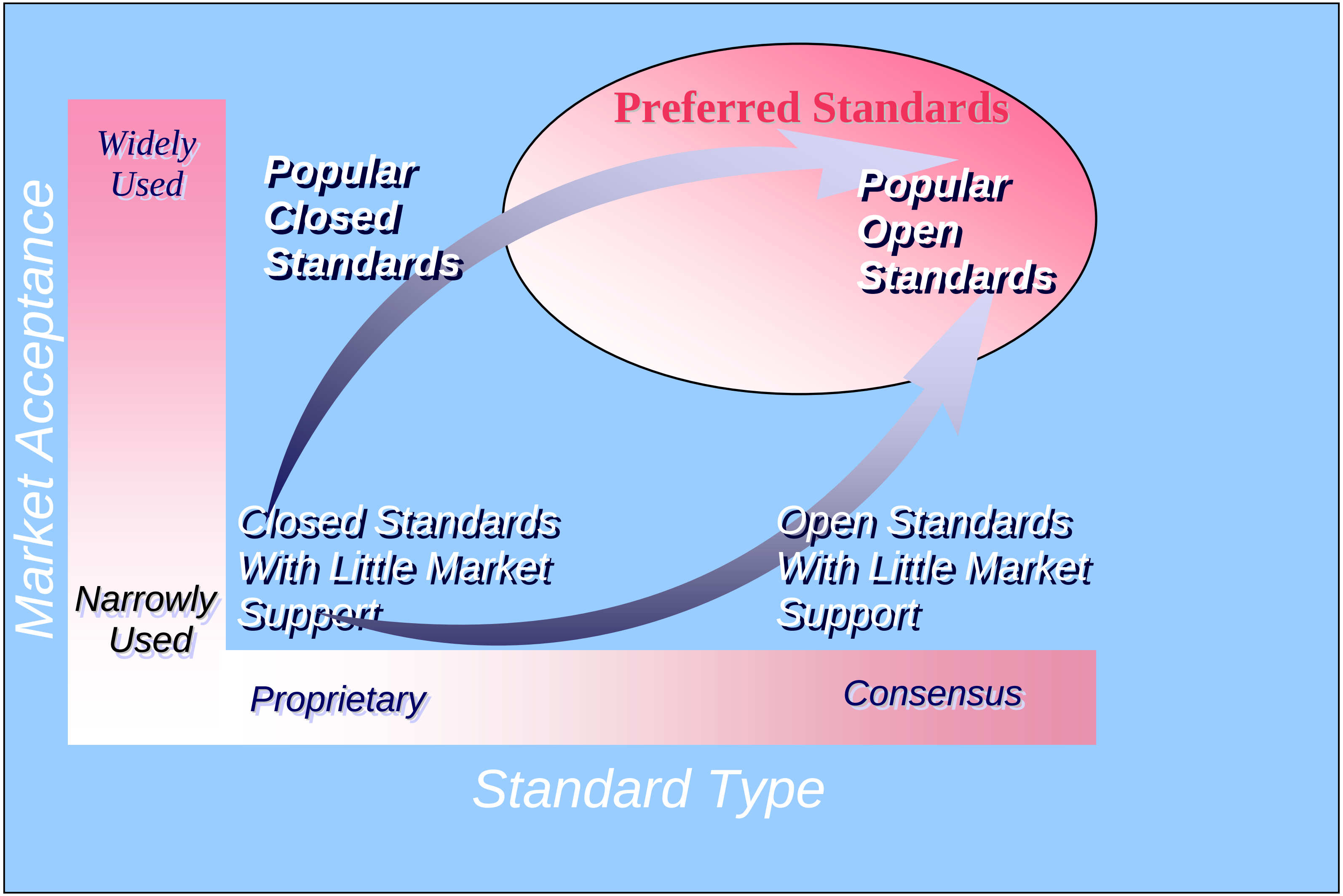
Goal is an Open RF Architecture Over Life Cycle

Public Law 104-113

- **With regard to non-government standards, Section 12d states:**

"(1) IN GENERAL. - Except as stated in paragraph (3) [exceptions] of this section, all Federal Agencies and departments shall use technical standards that are developed or adopted by voluntary consensus standards bodies, using such technical standards as a means to carry out policy objectives or activities determined by the agencies and departments.

Preferred Standards

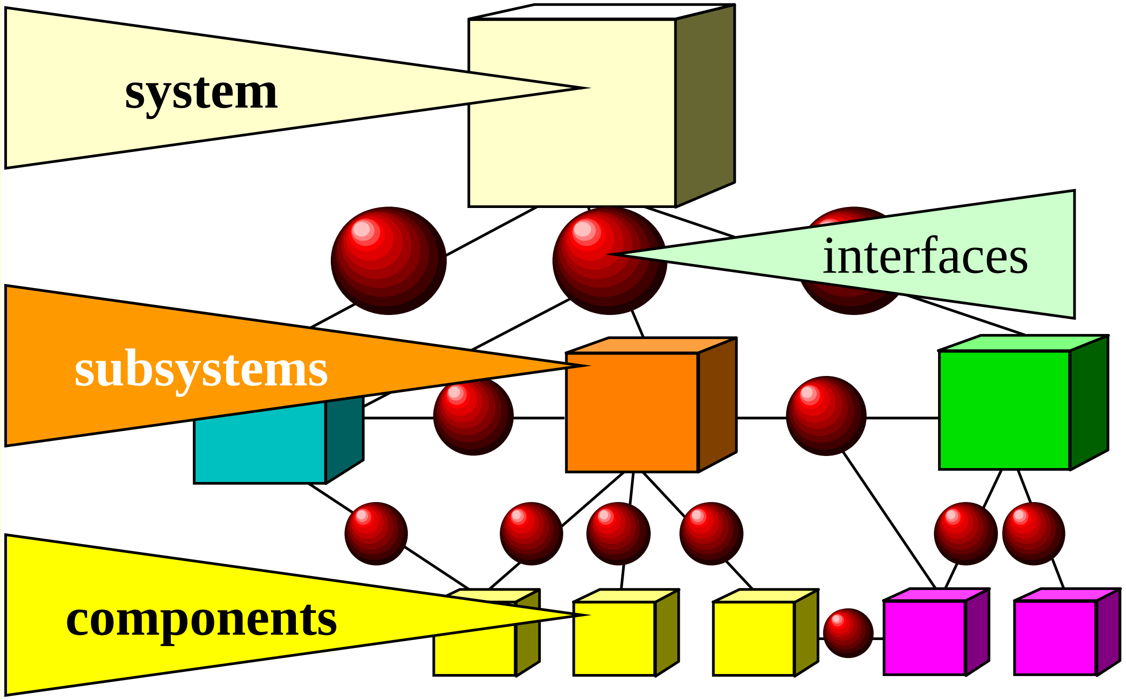


Definitions

A **system** -
is a collection of
interacting...

...**subsystems** -
which are collections of
interacting...

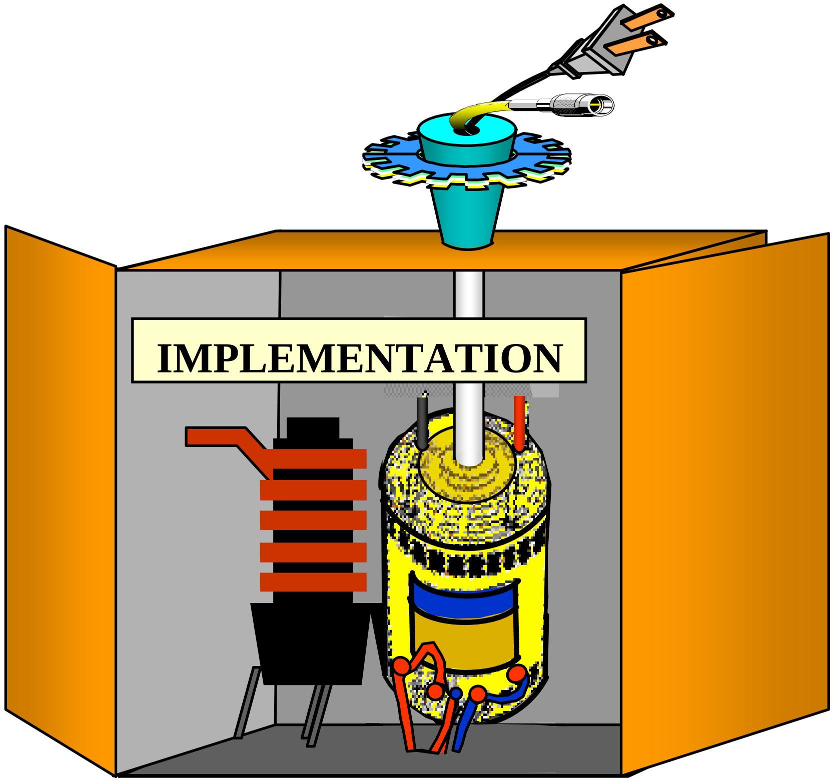
...**components** -
either hardware,
software, or human, ...



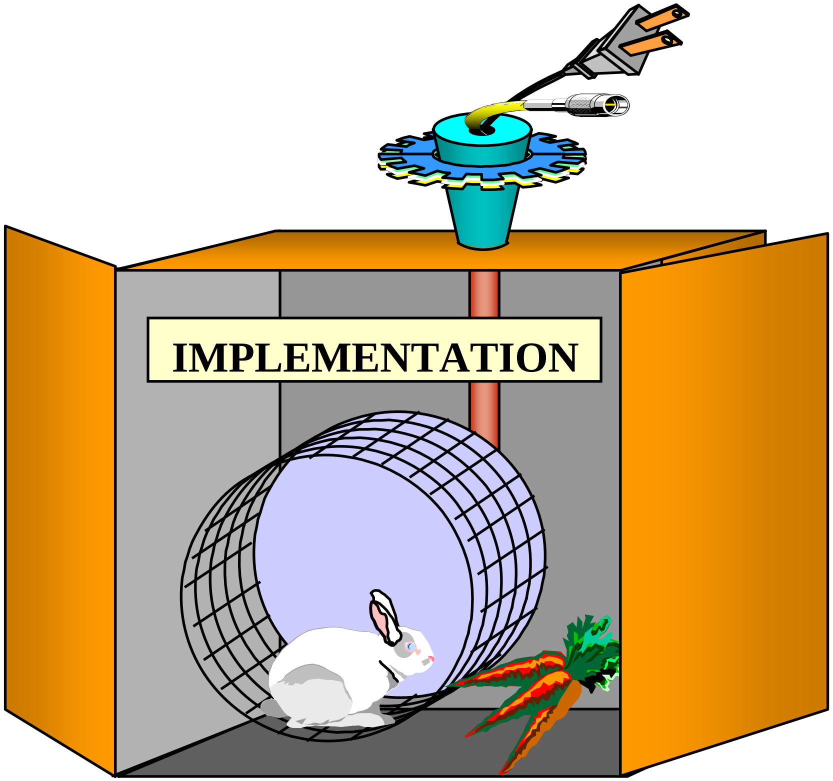
…that are connected by **interfaces** -
to support the interchange of information, activity, or material essential to the functioning of the system.

Intellectual Property

Developer can choose <u>any</u> implementation as long as design meets interface specification.

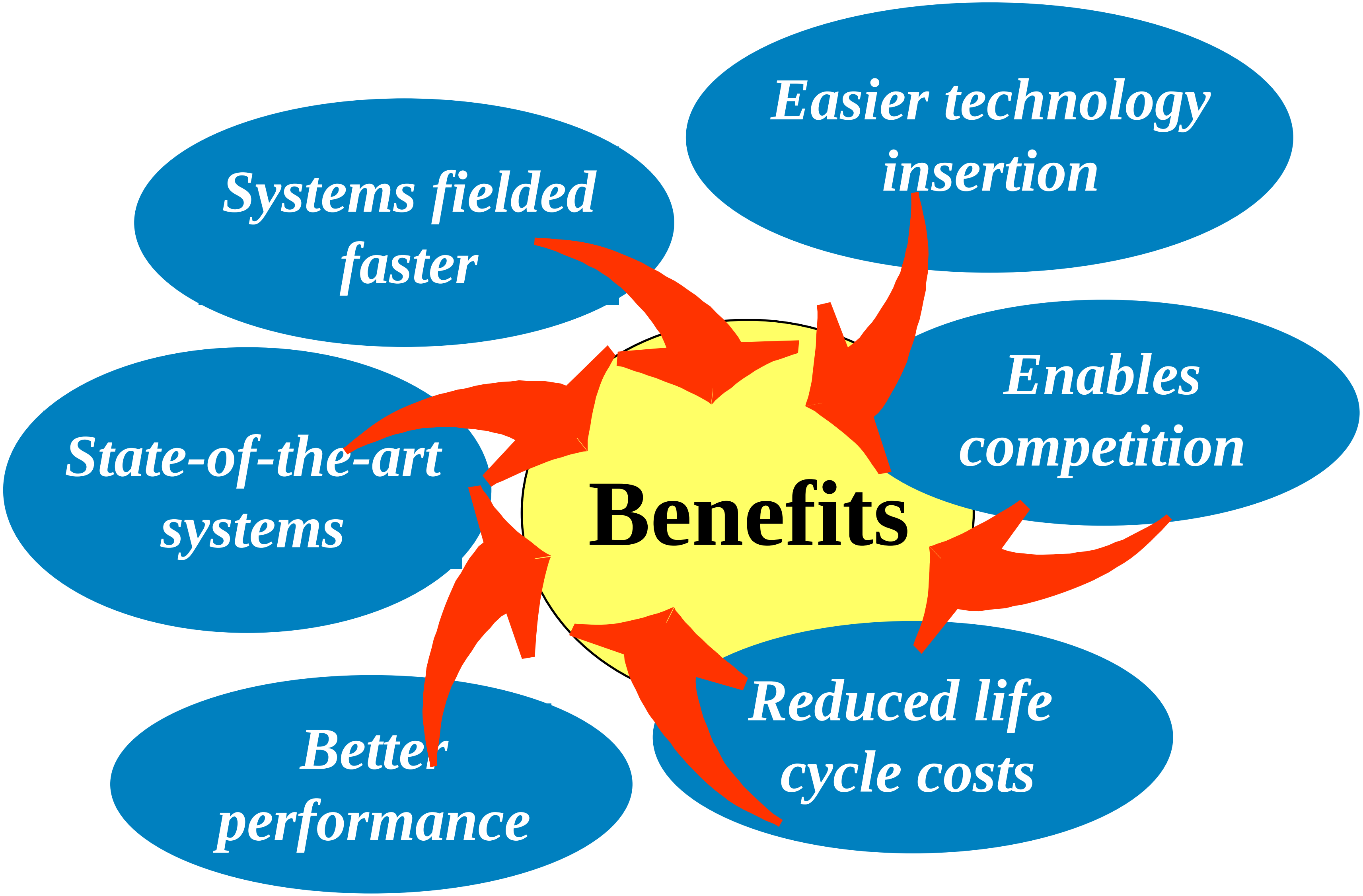


Component A

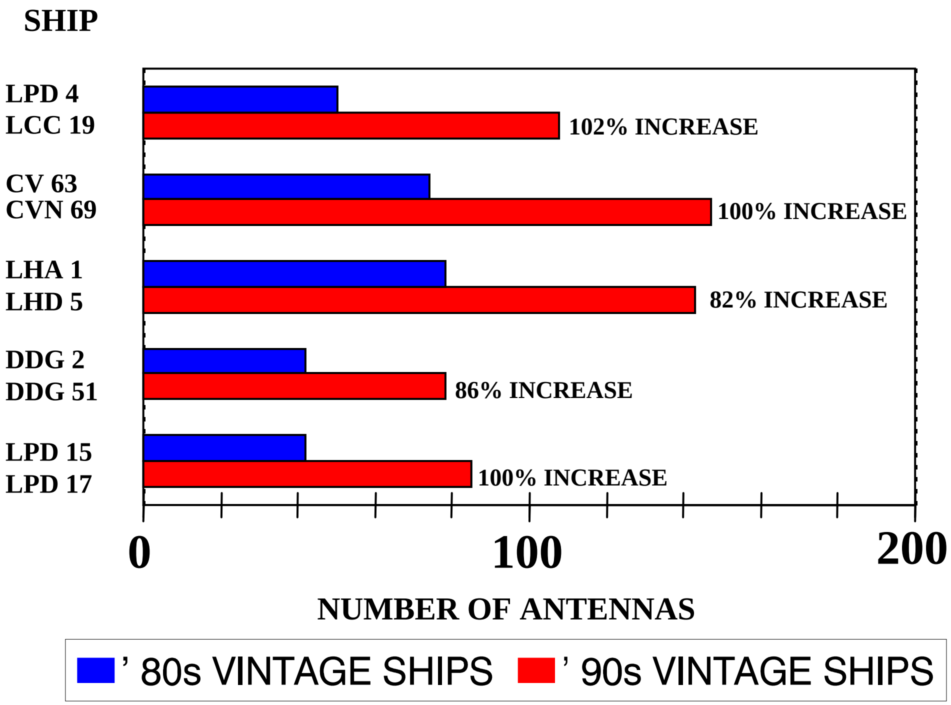


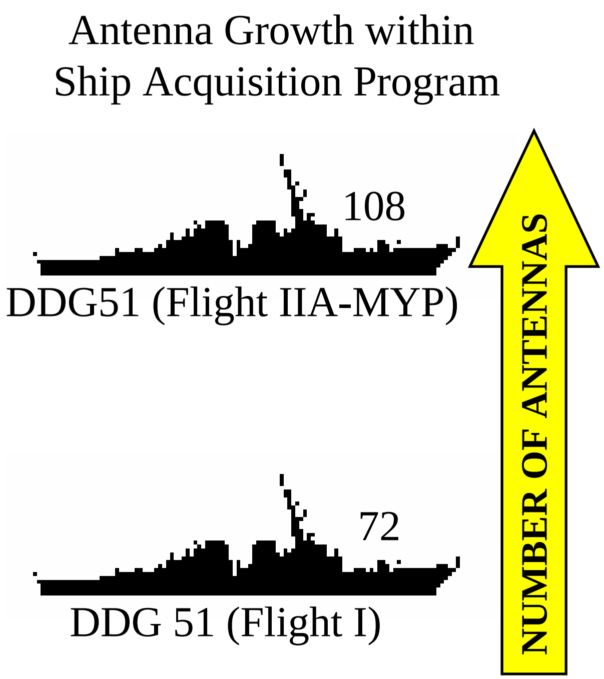
Component B

Benefits of Using Open Systems Standards



Motivation: Shipboard Antenna Growth





Integrated Topside (IT) Objective

- Develop and demonstrate an integrated, multi-function, multi-beam top-side aperture construct that has:
  - A scalable family of EW & communications capability to support multiple classes of ships
  - Shared apertures for multiple functions
  - Software defined functionality
  - Cost effectiveness over the life cycle
  - Increased operational capability
  - Spiral development to reduce risk and costs and have high probability for transition of technology to the fleet
  - Modular open design (apertures and electronics) to facilitate competition

Next Steps

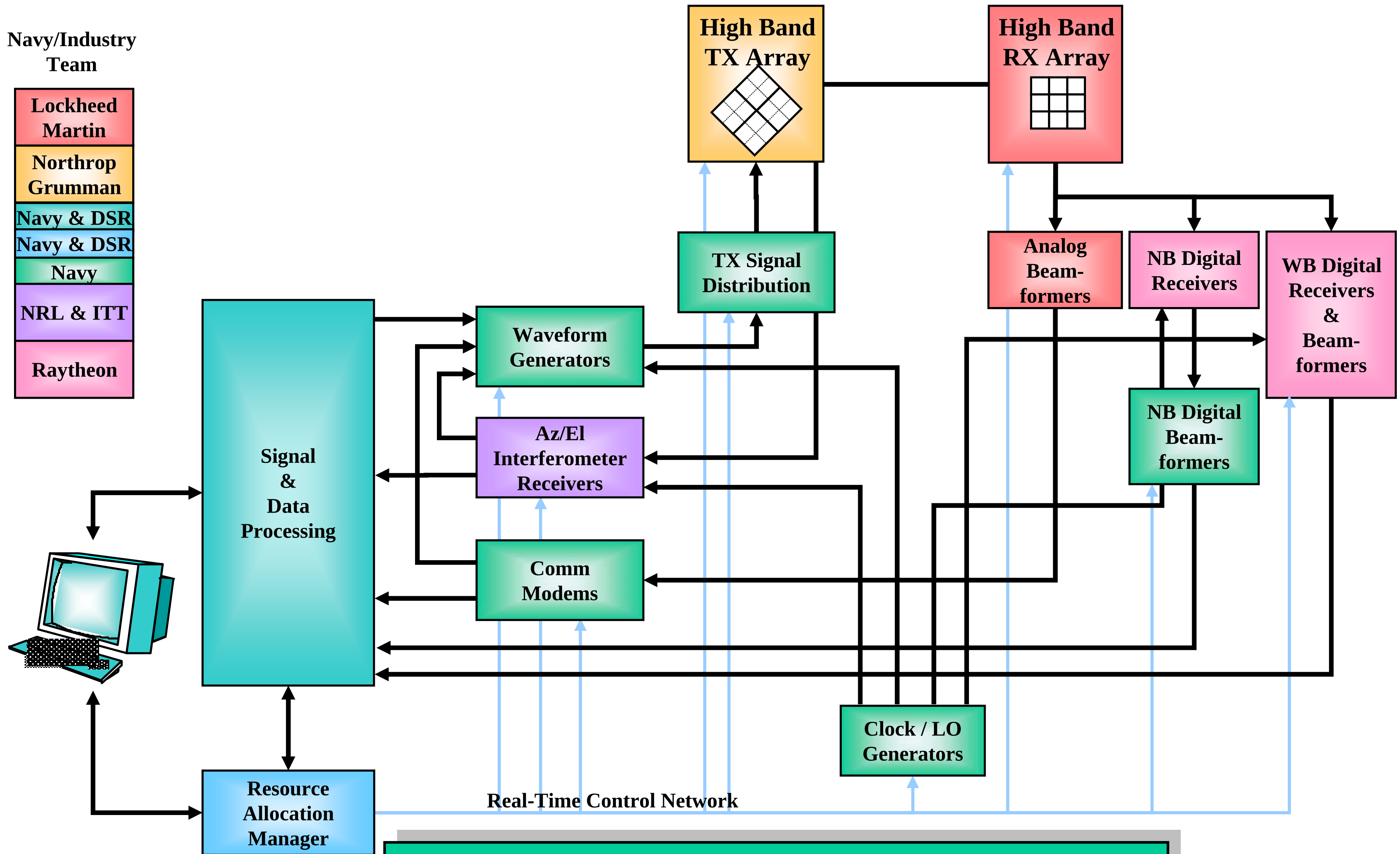
- Reviewed industry responses to NDIA questionnaire and issued RFI for industry to define strategies for developing specific architectures and interfaces (responses due 20 April 2007)
- Implement a management IPT that includes services, SECNAV, OPNAV, acquisition community
- Prepare for contract(s) in early FY08
- Continue coordination with other potential users (Army, Air Force, NAVAIR)

Prepare to initiate IT Program in earnest when funding available.

Advance Multi-Function RF Concept

AMRFC Site Today

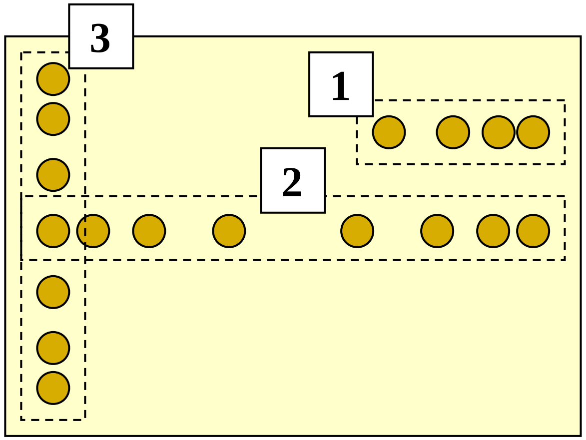
AMRF-C Test-Bed High Level Block Diagram



Broad Industrial Base Involvement

Multi-Function EW System for DDG - 1000

MFEW Passive Arrays for DDG - 1000



1 (4) HPOI / Acquisition elements arranged as 4-element interferometer with 3x LOB accuracy of SLQ-32 at the horizon.

2 (8) Az PDF elements with 33” baseline provide compliant performance in all sea states, ship maneuvers, and signal polarizations.

3 (7) El PDF elements provides compliant performance in all but worst case conditions but may exceed top hat height restrictions.

Other Ship Classes

- DEEP WATER
  - SMALLER SHIPS (PATROL CRAFT, ETC):
  - NATIONAL SECURITY CUTTER: SLQ-32 REPLACEMENT
  - POTENTIAL FOR MISSION/CAMPAIGN BASED EQUIPMENT LOADS
- LCS
  - REDUCED SIZE/WEIGHT COMPARED TO SLQ-32
  - INCREASED COST ABOVE CURRENT FLIGHT 1 SOLUTIONS OFFSET BY INCREASED CAPABILITY AND REDUCED LOGISTICS COSTS
- BACK FIT SHIPS
  - SLQ-32 REPLACEMENT SIMPLIFIED BY USING ESE
  - SCALABLE FROM “SLQ-32 LITE” TO DD(X) PERFORMANCE
- CG(X)
  - DD(X) CONFIGURATION
- CVN-21, LHA
  - SEVERE SPACE LIMITATIONS ON ISLAND
  - INVESTIGATE P/S OR 4 QUADRANT INSTALLATIONS OFF ISLAND

Multi-Function EW System
One System - Modular & Scalable

MF
(EA)

ES
SA

PDF
SEI

SA
MDF
RWR

≥ $XXM

(1-5)

Unique application / installation

(5-30)

Future combatants passive sensors
DDG-1000, CG(X), etc.

(100-200)

Back fit SLQ-32 replacement
DDG, CG, etc.

(5-10)

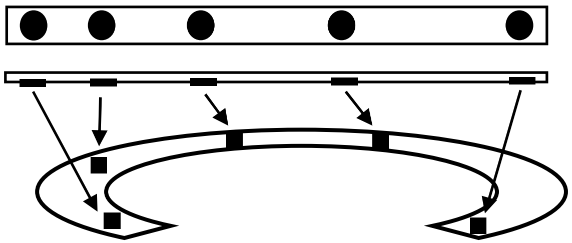
Future SLQ-32 V2 replacement
Deep Water National Security Cutter

≤ $YM

(30-50)

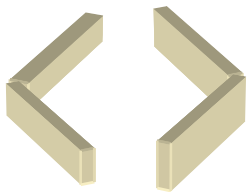
Small ship self protection
LCS, Deep Water OPC & FRC

Rx Aperture Options



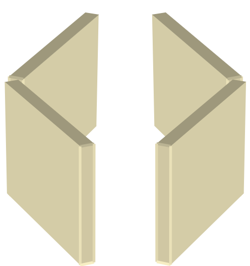
1 panoramic circular array interferometer

- Acquisition
- Precision DF (< 1°AOA)
- SEI
- EA techniques



4-element interferometer per quadrant

- Acquisition
- Medium DF (1°LOB)
- SEI
- EA techniques



14-element interferometer per quadrant

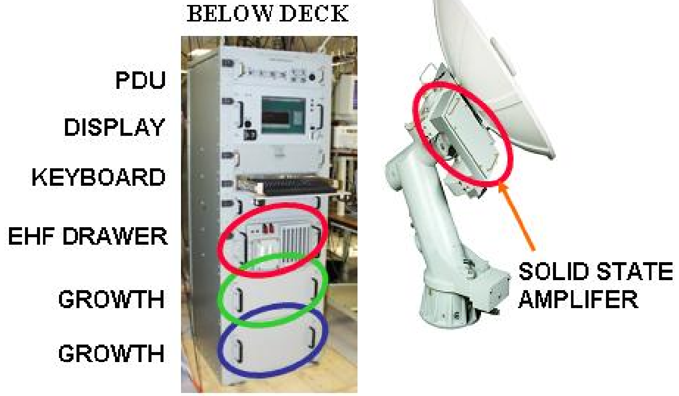
- Acquisition
- Precision DF (< 1°AOA)
- SEI
- EA techniques

Modular Integrated Link Electronics System (MILES)

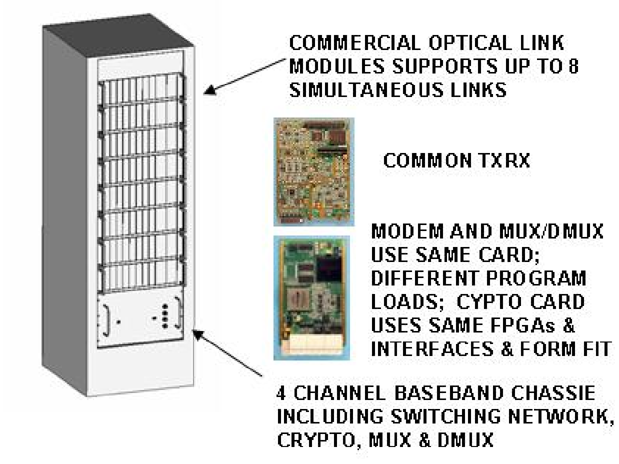
MILES

CDL-S EQUIPMENT SINGLE LINK

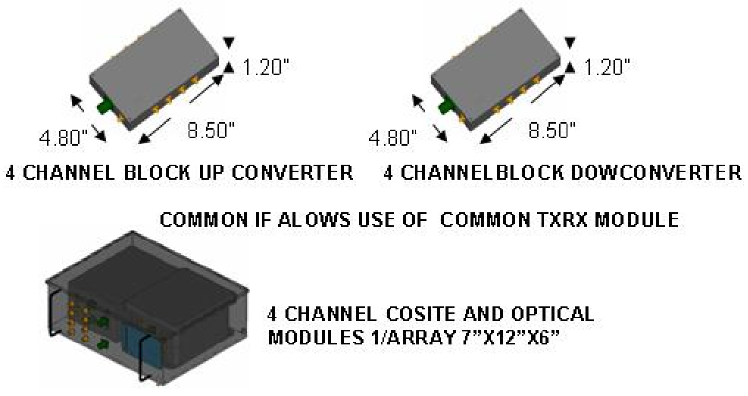
EHF SATCOM SYSTEM SINGLE LINK



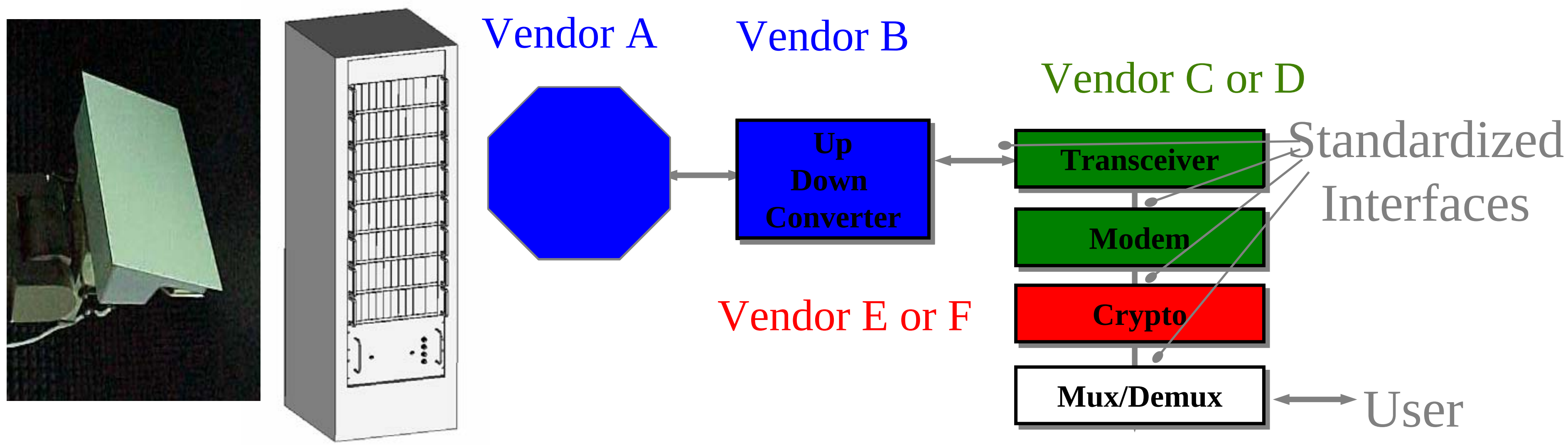
MILES BELOW DECKS-8 LINKS



MILES ABOVE DECKS



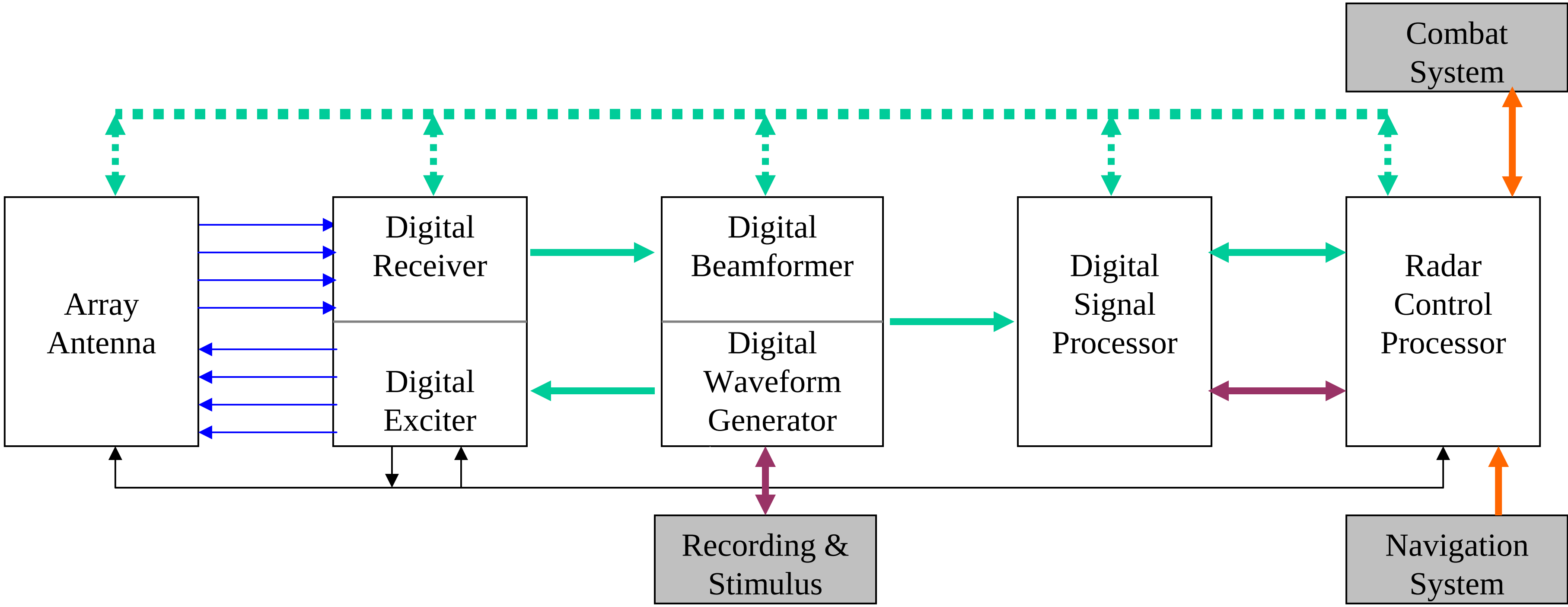
Modular RF System Architecture



- Procure Up / Down-converter with Array to a Common Set of IF Frequencies
  - All Arrays Have a Standard RF Interface to Support Electronics
- Defined Interfaces Between Back-End Electronics Subsystems
- Common architecture for ground / airborne terminal applications
- Migrate to Digital Data Interface From Array To Below Decks Electronics

Digital Array Radar (DAR)

DAR Open Architecture Radar Specification (OARS)



Analog Signal Lines

Digital Messages (defined in DAR Interface Control Document)

Digital Messages (defined elsewhere, but referenced by DAR ICD)

Digital Messages to be defined in future

Clock lines

DAR Subsystems

External Subsystems

Modular architecture allows subsystem development by multiple vendors

Summary

Objective is to develop concept for RF Modular Open System Architecture to:

- Provide for RF systems that can be scalable across multiple platforms
- Enable multiple vendors to provide best of breed for the subsystems
- Enable rapid, innovative upgrades over the systems life cycle
- Cost effectiveness over the life cycle

ASN (RDA)
Chief Systems Engineer

NDIA
8th Annual Science Engineering Technology Conference

Systems Engineering View of Naval Warfighting Systems Development

Mr. Carl Siel
ASN(RDA) Chief Systems Engineer
carl.siel@navy.mil

18 April 2007

Bottom Line, Up Front

The real issue is a lack of a Navy-wide System Engineering & Analysis Process

System Engineering & Analysis applied horizontally across programs enables determination of appropriate modularity

RDA CHENG Charter *

RDA CHIEF SYSTEMS ENGINEER

Mission

Senior Advisor to ASN (RDA) for System Engineering, Software Development and Net-Centric Integration and Interoperability

Duties / Responsibilities / Authorities

System Engineering / Software Development

- Application and assignment of policies, processes, practices
- Application of new techniques and practices
- Participate in milestones reviews
- Health of Workforce
- OSD, Joint and Coalition representatives

Net-Centric Integration and Interoperability

- Policies, processes and practices
- C4I and IT systems overall combat weapon architectures
- Develop I&I processes
- OSD, Joint and Coalition and Federal representation

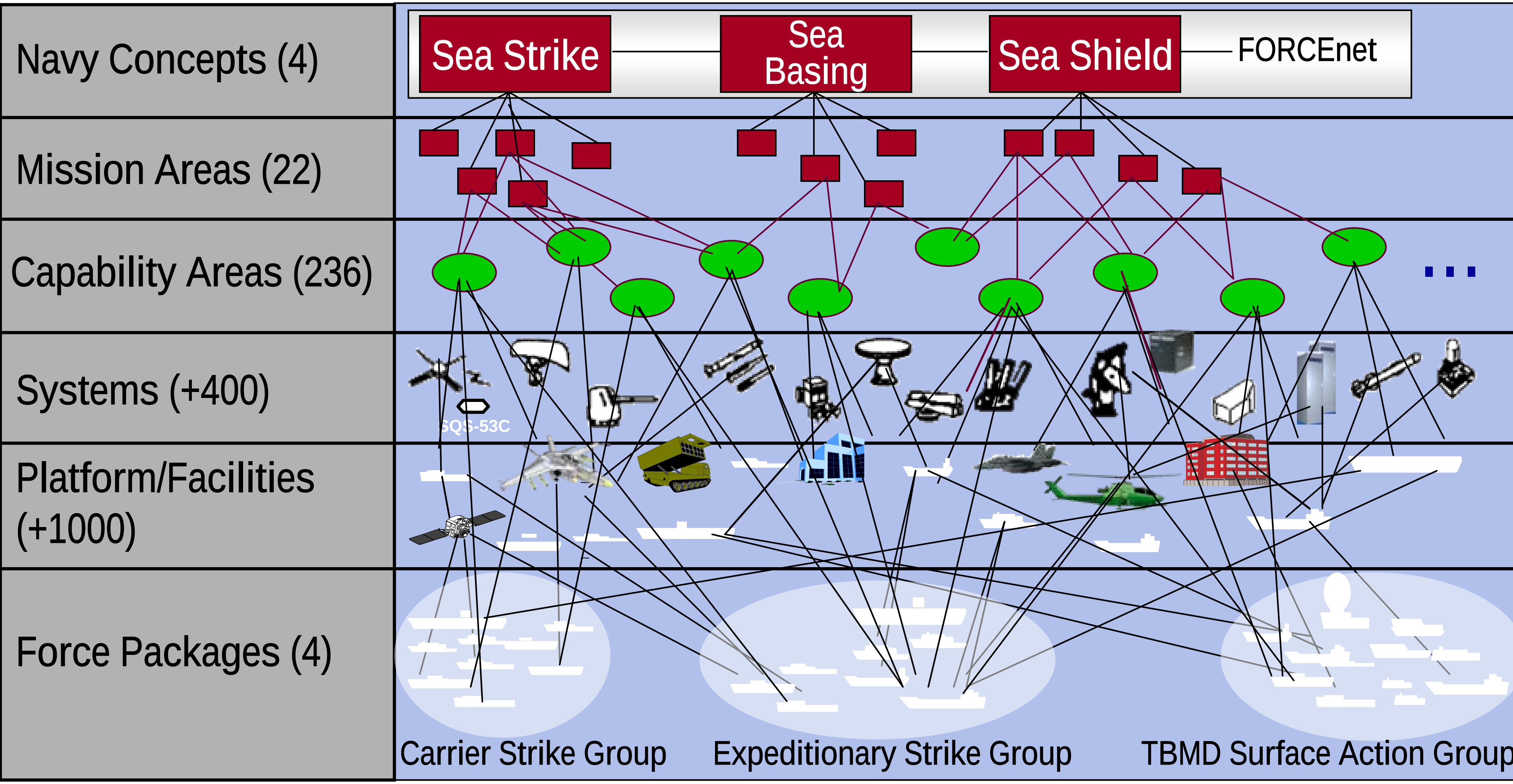
Other

- Modeling and Simulation
- Technology Protection

* Updated, in review with ASNRDA

Capability-Based System Engineering Complexity

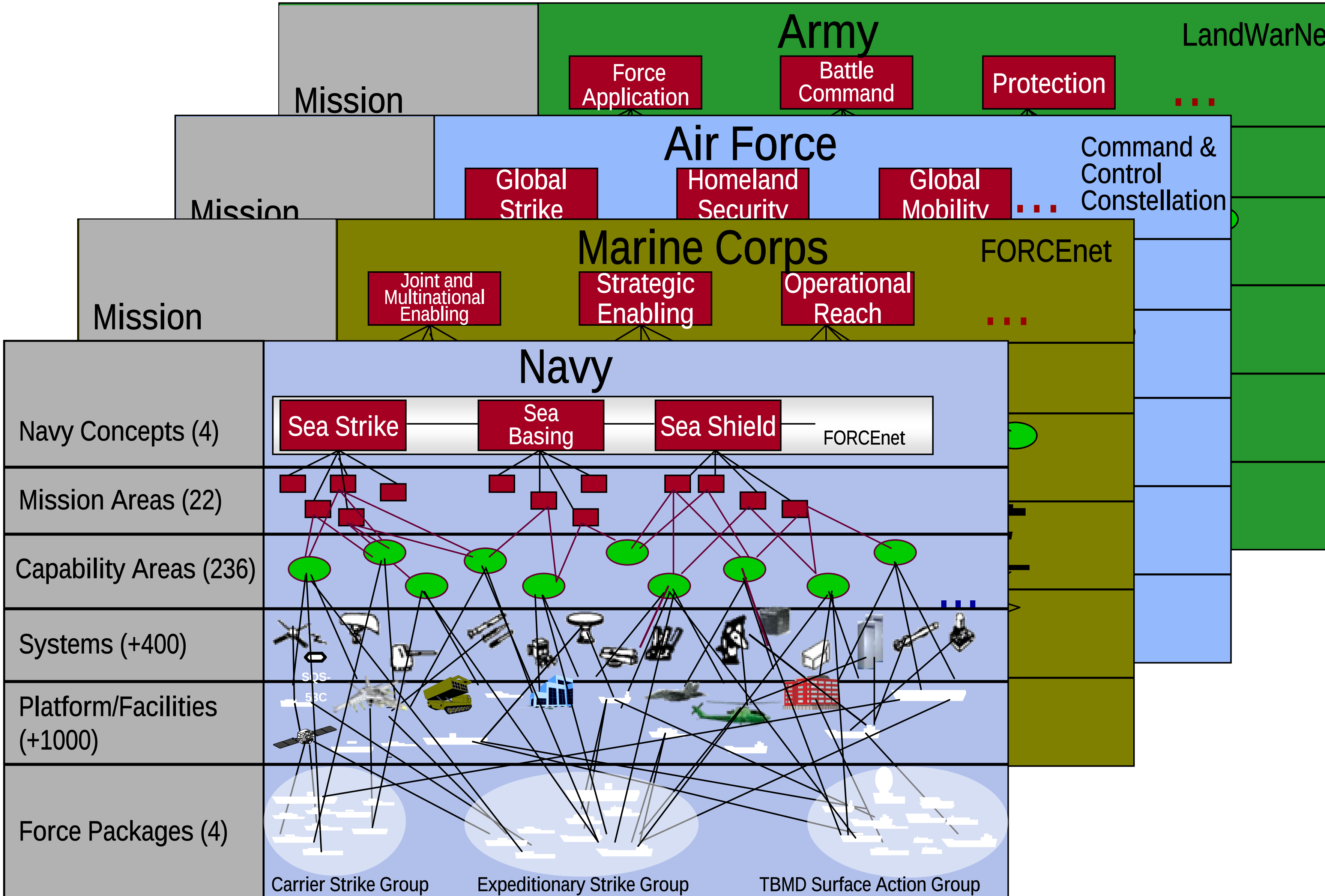
RDA
CHIEF
SYSTEMS
ENGINEER

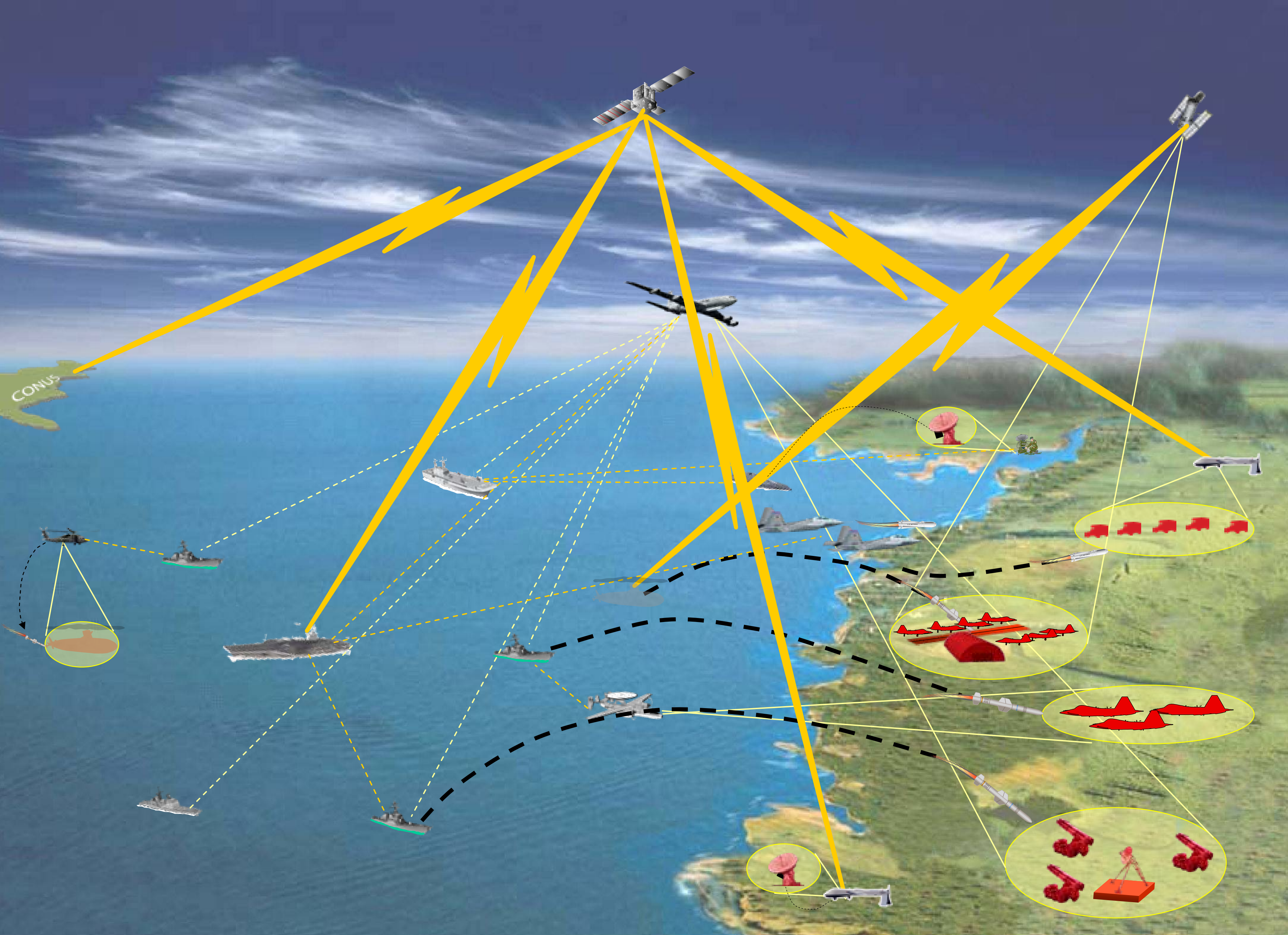


Globally Networked, Distributed Combat Force

Composed of: Multimission systems on multimission units deployed in multiple force packages

Joint Interoperability Challenge




CONUS

…	Fire Control	Deconfliction	Situational Awareness	Combat ID	Common Operational Picture	Persistent ISR
Joint Access and Denial						
Joint Land Operations						
Joint Maritime / Littoral Operations						
Joint Air Operations						
⋮						

Recommendations

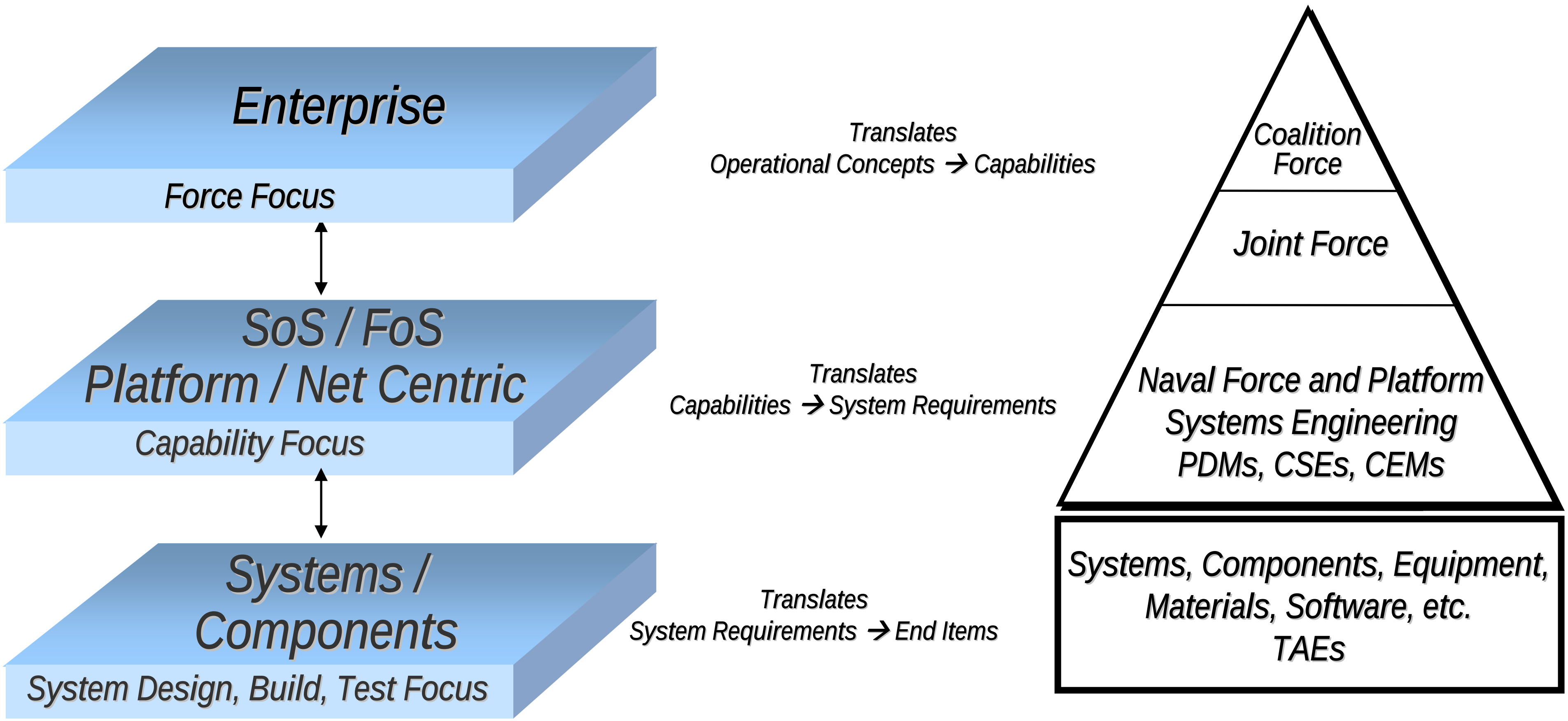
- ASN (RD&A), with VCNO and ACMC, take lead in ***developing a Naval-wide System-of Systems Engineering function*** that follows a top-down, interactive, recursive, system synthesis & analysis process to define requirements.

- CNO & CMC ***identify driving factors*** for modularity and develop Naval policy and guidance for implementing modularity.

- CNR ***lead as technology change agent*** for:
  - Development of methodologies for understanding complex systems, enabling modular design
  - Experimentation with modular systems to support acquisition spirals
  - Development of M&S tools to enable system of systems engineering analysis
  - Development of advanced concepts & tools for software optimization & reuse

Capability-Based System Engineering

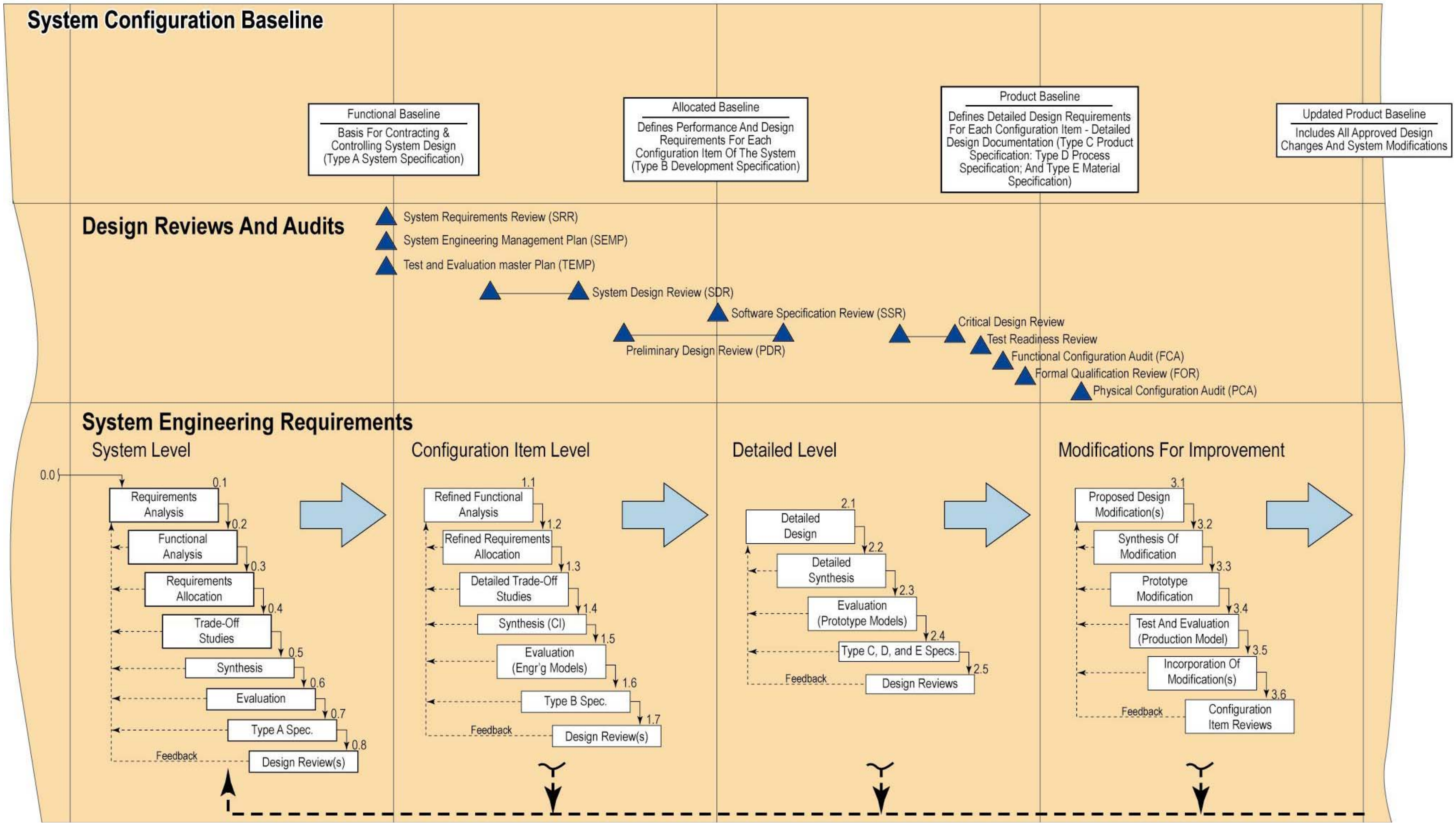
RDA CHIEF SYSTEMS ENGINEER



Requires Alignment of Multiple Processes, Process Owners and Products

System Engineering Process

RDA
CHIEF
SYSTEMS
ENGINEER

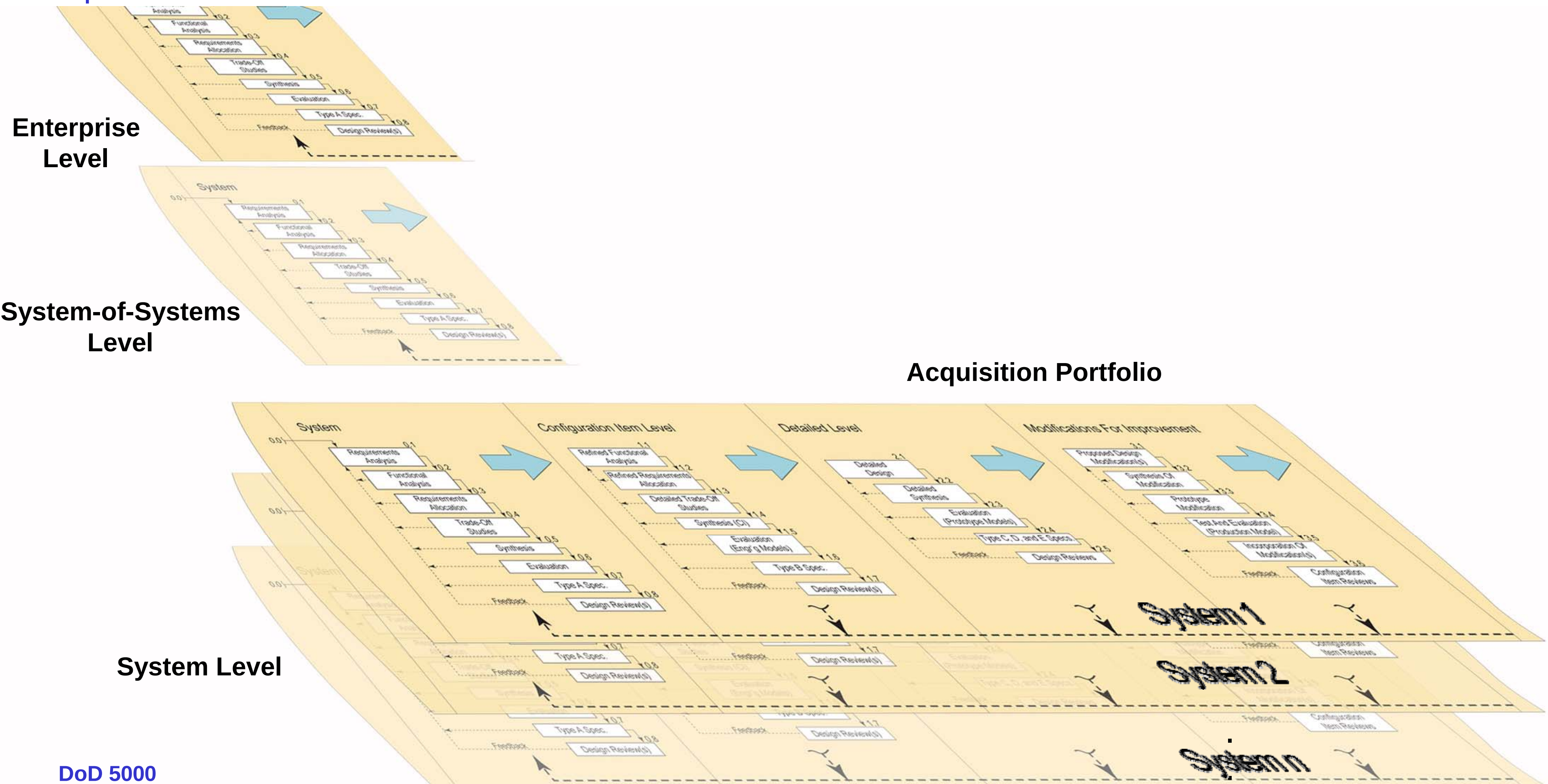


Engineering Enterprise - SoS - System

RDA CHIEF SYSTEMS ENGINEER

Mission Concept Refinement	I	Capability Maturity	II	System of Systems Development & Demonstration Systems Integration / Capability Demonstration	III	Deployment Mission Execution	Operations & Support Sustainment / Disposal

Proposed SoS Process

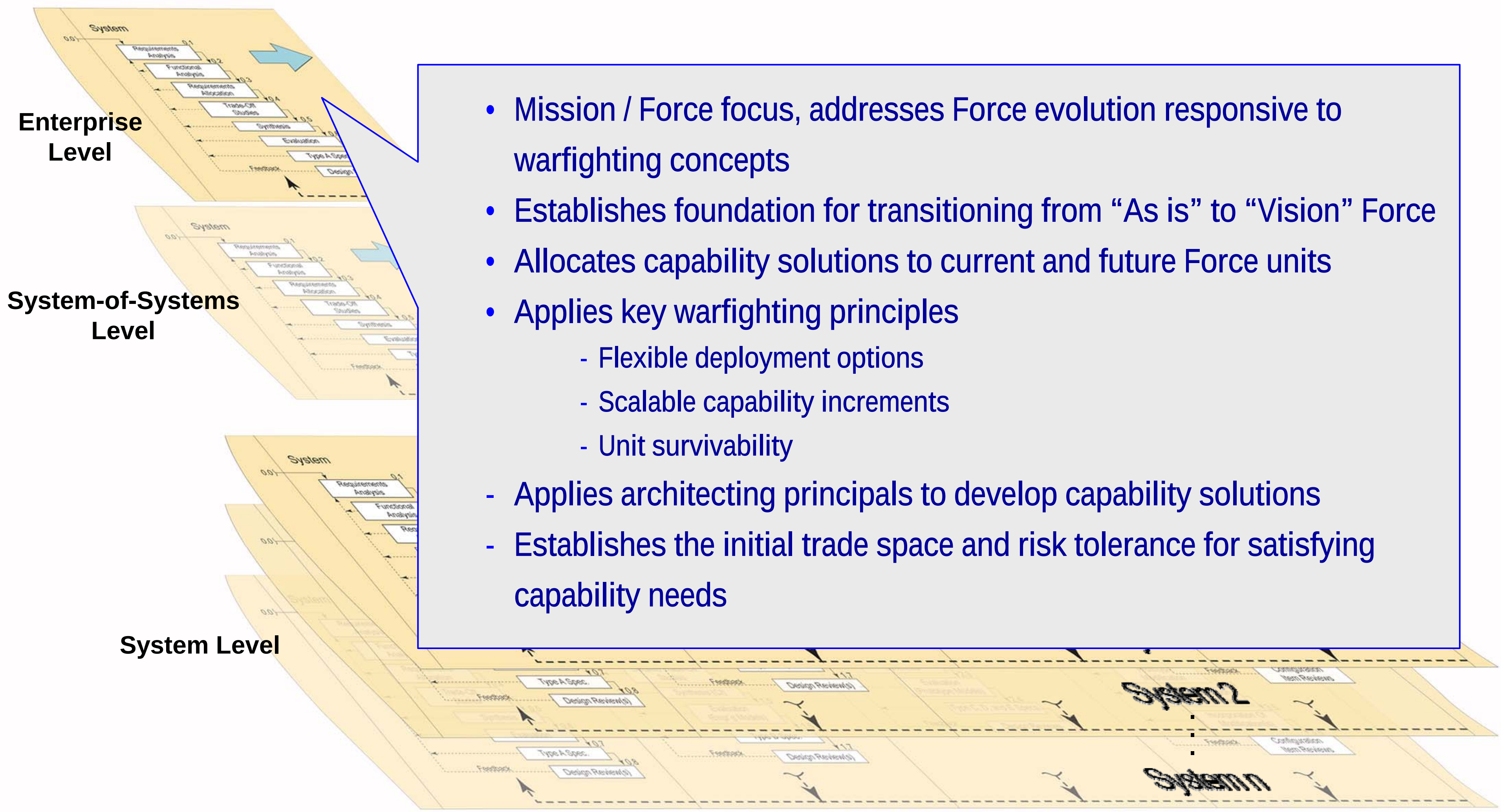


DoD 5000

Functional Area Analysis	Functional Needs Analysis	Functional Solutions Analysis	Analysis of Alternatives	A	Technology Development	B	System Development	C	Production

System Engineering: Enterprise Level

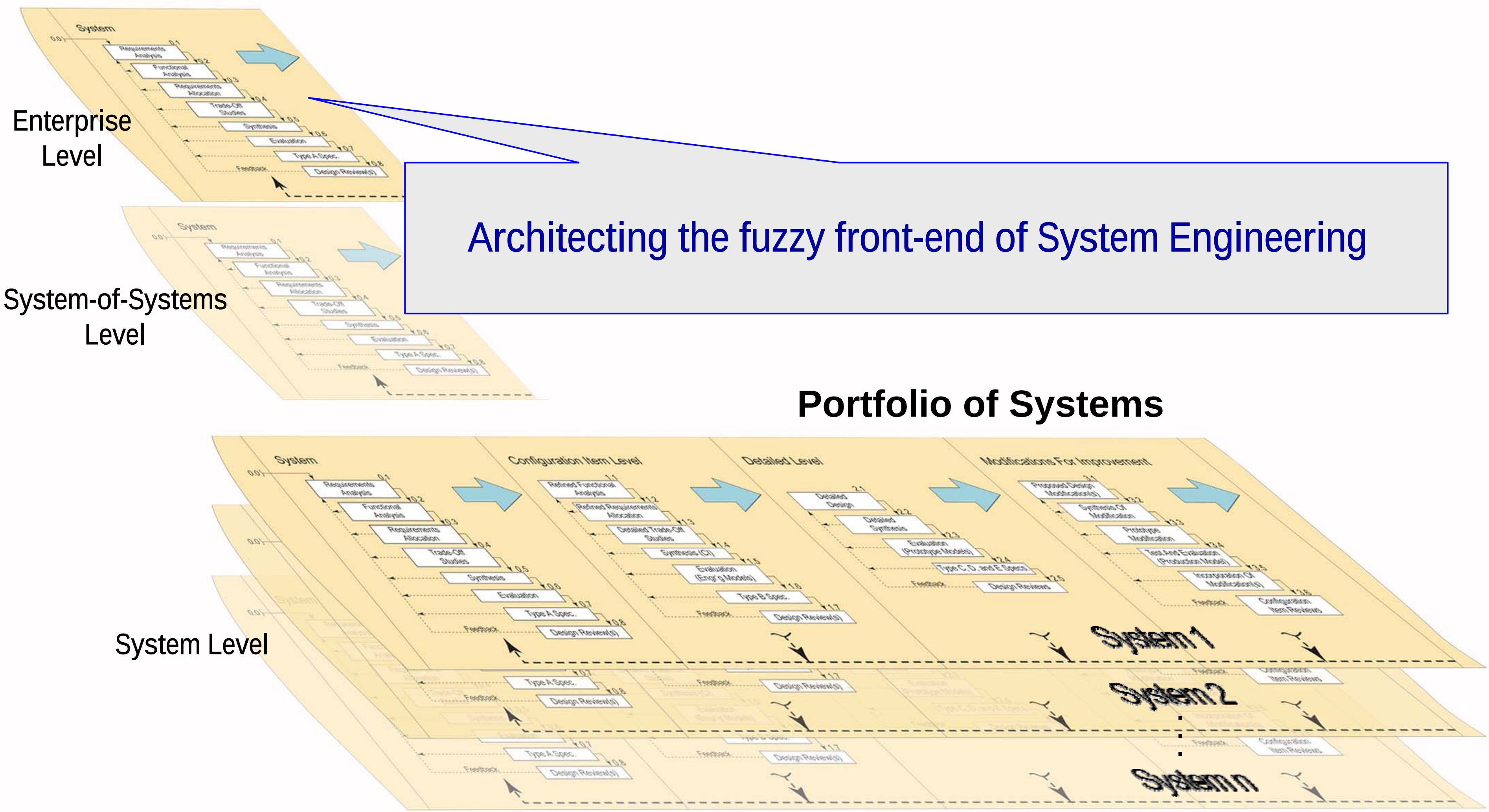
RDA CHIEF SYSTEMS ENGINEER



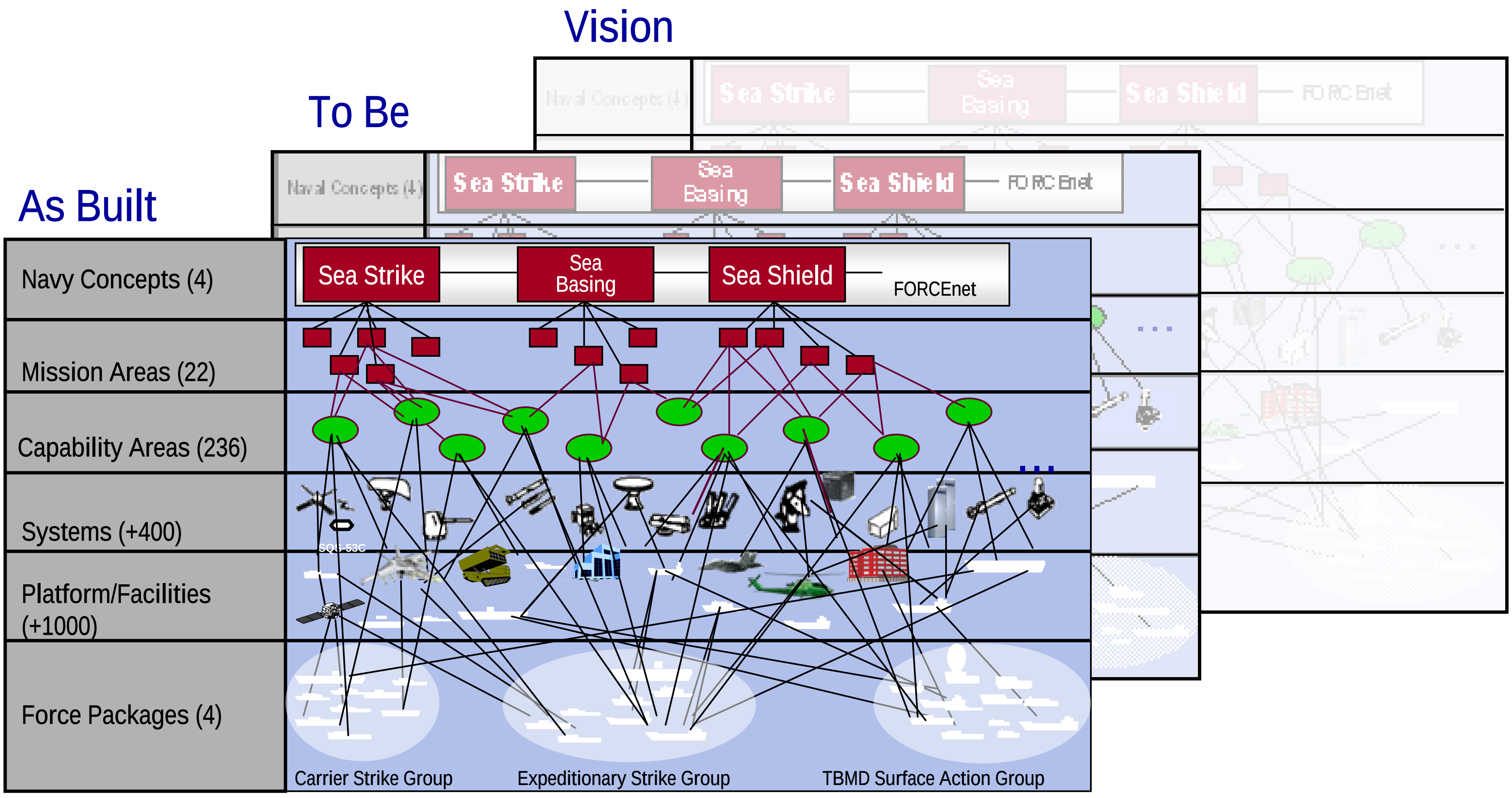
- Mission / Force focus, addresses Force evolution responsive to warfighting concepts
- Establishes foundation for transitioning from “As is” to “Vision” Force
- Allocates capability solutions to current and future Force units
- Applies key warfighting principles
  - Flexible deployment options
  - Scalable capability increments
  - Unit survivability
- Applies architecting principals to develop capability solutions
- Establishes the initial trade space and risk tolerance for satisfying capability needs

System Engineering: Enterprise Level

RDA CHIEF SYSTEMS ENGINEER



Evolution Planning



Align Capability and System / Unit Evolution Paths

Operational Architecting Principles

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• Flexibility	Constitute and Re-constitute Force
• Survivability	Fight and Survive or fight hurt
• Multi-mission	Assign / reassign Missions in Real/time
• Scalability	Support range of Operations/OPTEMPO

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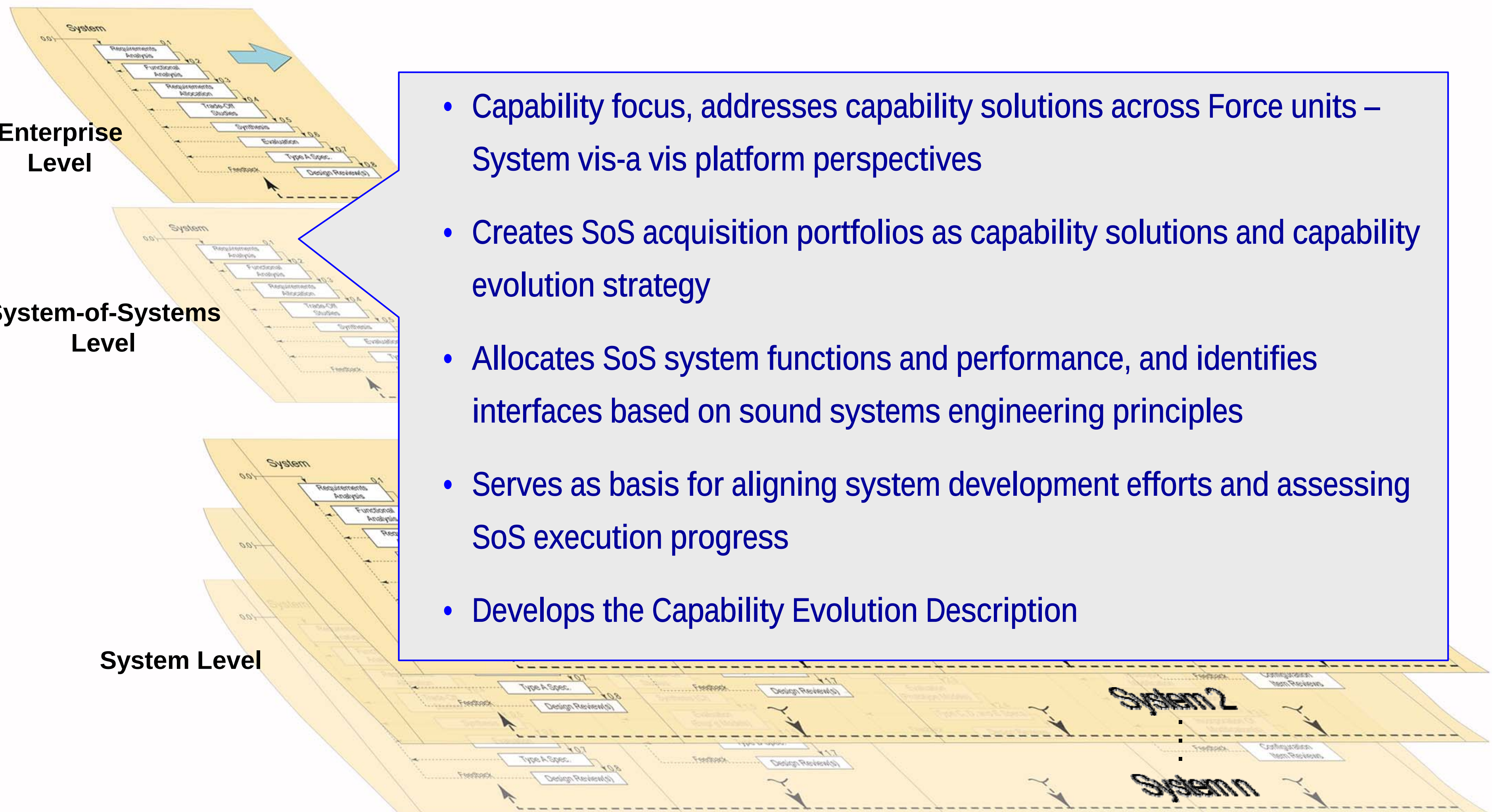
RDA CHIEF SYSTEMS ENGINEER

System Architecting Principles

• Modularity	Loosely Coupled Federation
• Connectivity	Only essential communications between elements
• Simplicity	Best for operation and acquisition
• Economy	People, material and funding
• Correspondence	Best match to Navy structure, mission, operations
• Continuity	Consistent Information, decision Rules
• Layering	Support Hierarchy – Command Thru Weapons
• Sustainability	Maintain capability, survival and readiness
• Compatibility	Constructive to existing systems
• Security	Must be sign in

System Engineering: SoS Level

RDA CHIEF SYSTEMS ENGINEER



- Capability focus, addresses capability solutions across Force units – System vis-a vis platform perspectives
- Creates SoS acquisition portfolios as capability solutions and capability evolution strategy
- Allocates SoS system functions and performance, and identifies interfaces based on sound systems engineering principles
- Serves as basis for aligning system development efforts and assessing SoS execution progress
- Develops the Capability Evolution Description

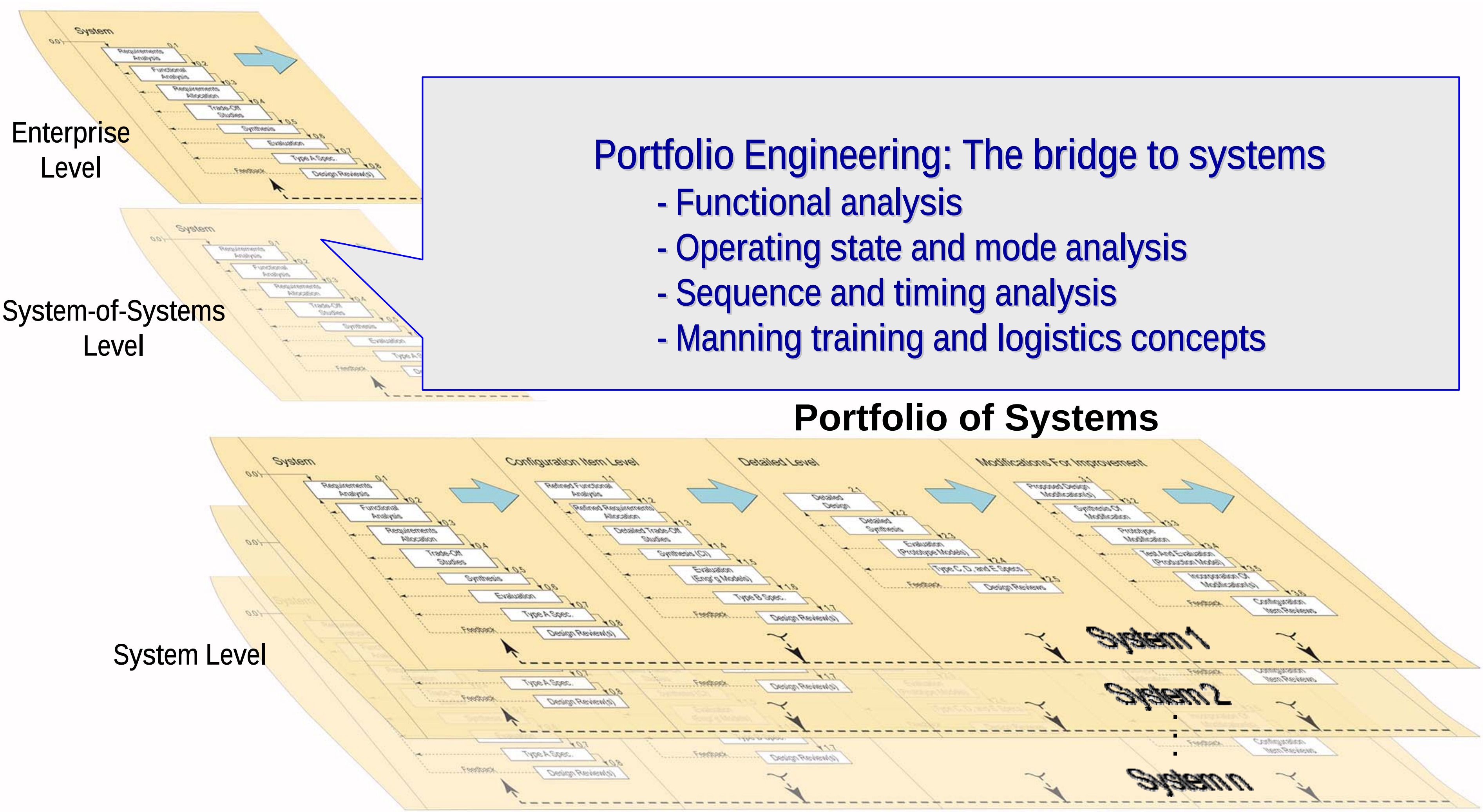
System Engineering: SoS Level

RDA Chief Systems Engineer

Enterprise Level

System-of-Systems Level

System Level

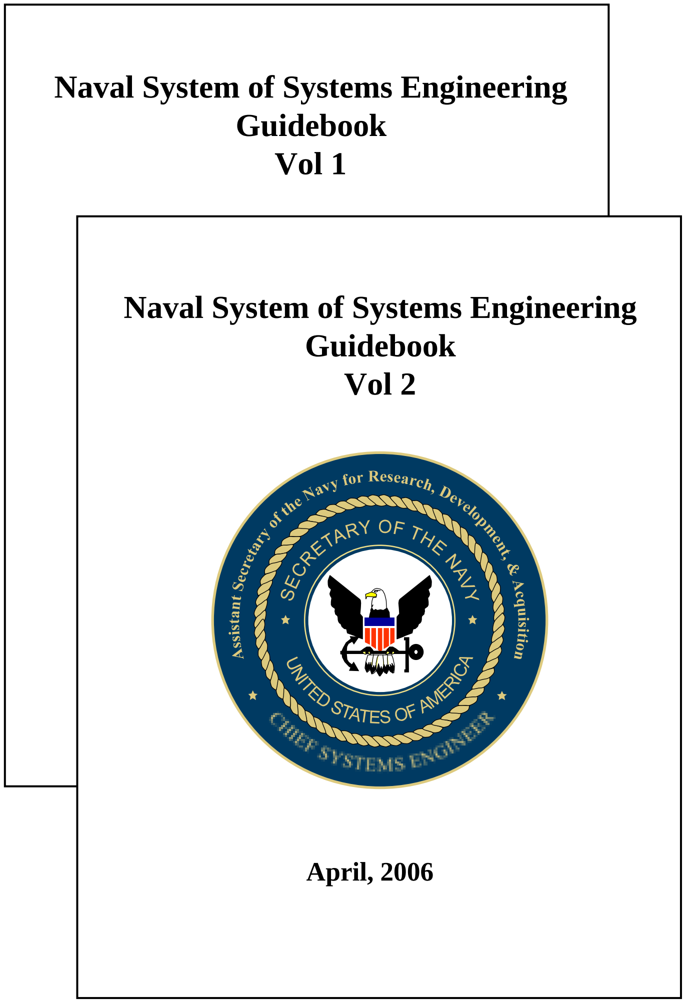


Engineering Capability…

- Time Allocations
- Error Budgets
- Fault Tolerance / Reconstitution
- Human System Integration
- Integrated Team Training
- Safety
  -
  -
  -

Horizontally Across Platforms and Systems

System of Systems Engineering


Naval System of Systems Engineering Guidebook Vol 1

Naval System of Systems Engineering Guidebook Vol 2

April, 2006

Naval SoSE Guidebook

- Developed to support Mission level capability-based acquisition decision making
- Presents best practices for capability-based acquisition and systems engineering
- Provides processes, methods, and tools to aid interoperable and integrated systems
- Particularly suited to System of Systems or Family of Systems
- Supports Naval or Joint Force Operations

Relationship to System Documentation

RDA CHIEF SYSTEMS ENGINEER

System Performance Document

Table of Contents

1.0 SCOPE
- 1.1 IDENTIFICATION
- 1.2 SYSTEM OVERVIEW
- 1.3 DOCUMENT OVERVIEW

2.0 APPLICABLE DOCUMENTS

3.0 REQUIREMENTS
- 3.1 REQUIRED STATES AND ROLES
- 3.2 SYSTEM CAPABILITY REQUIREMENTS
- 3.3 SYSTEM EXTERNAL INTERFACE REQUIREMENTS
- 3.4 SYSTEM INTERNAL DATA REQUIREMENTS
- 3.5 ADAPTATION REQUIREMENTS
- 3.6 SAFETY REQUIREMENTS
- 3.7 SECURITY AND PRIVACY REQUIREMENTS
- 3.8 SYSTEM ENVIRONMENTAL REQUIREMENTS
- 3.9 COMPUTER RESOURCE REQUIREMENTS
- 3.10 SYSTEM QUALITY FACTORS
- 3.11 DESIGN AND CONSTRUCTION CONSTRAINTS
- 3.12 HUMAN SYSTEM INTEGRATION REQUIREMENTS
- 3.13 TRAINING RELATED REQUIREMENTS
- 3.14 LOGISTICS RELATED REQUIREMENTS
- 3.15 OTHER REQUIREMENTS
- 3.16 PACKAGING REQUIREMENTS
- 3.17 PRECEDENCE AND CRITICALITY REQUIREMENTS

4.0 QUALIFICATION PROVISIONS

5.0 REQUIREMENTS TRACTABILITY

6.0 NOTES

System Specifications

System N

System 2

System 1

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- 1.3 DOCUMENT OVERVIEW

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6.0 NOTES

Test and Evaluation Master Plan

System N

System 2

System 1

Table of Contents

1 Part I - System Identification

2 Part II - Integrated Test Program Summary

3 Part III - Development Test and Evaluation Outline

4 Part IV - Operational Test and Evaluation Outline

5 Part V - Test and Evaluation Resource Summary

Annexes

Relationship to System Documentation

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ENGINEER

System Performance Document

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System Specifications

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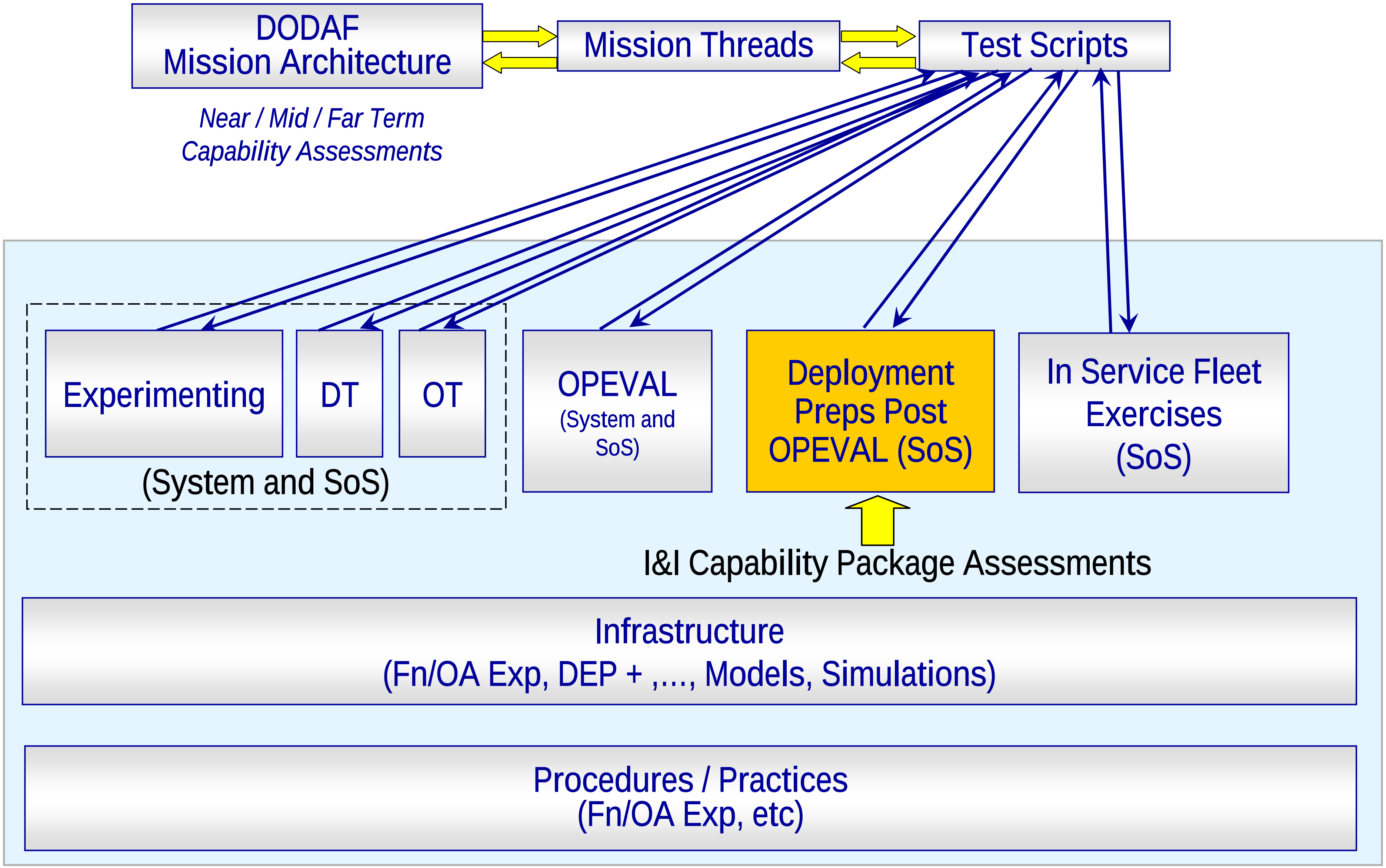
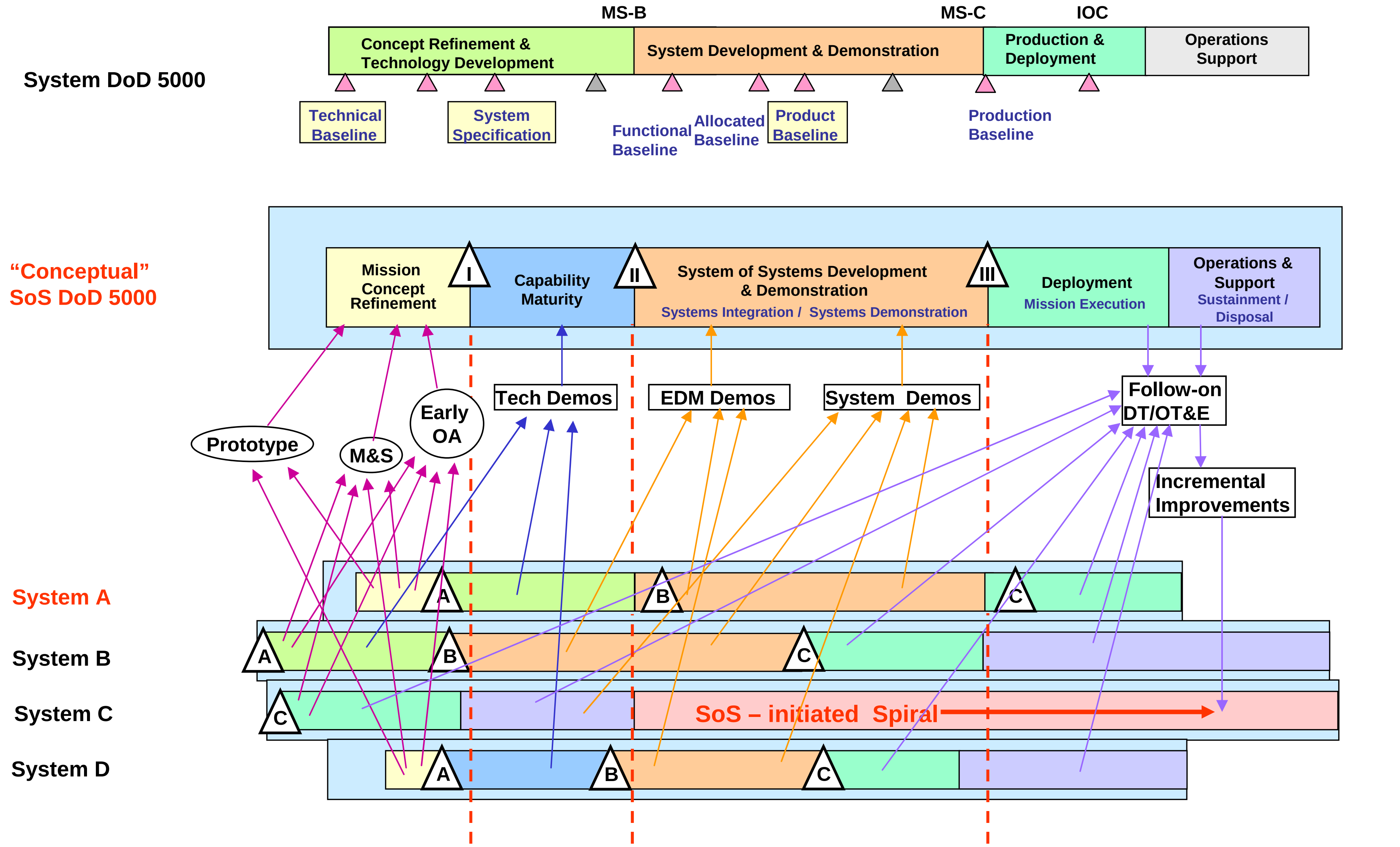
Large Scale SoS Capability Evaluations

RDA CHIEF SYSTEMS ENGINEER



Integrated SoS Life Cycle Interoperability Test Strategy

RDA CHIEF SYSTEMS ENGINEER



Using the SoS Guidebook

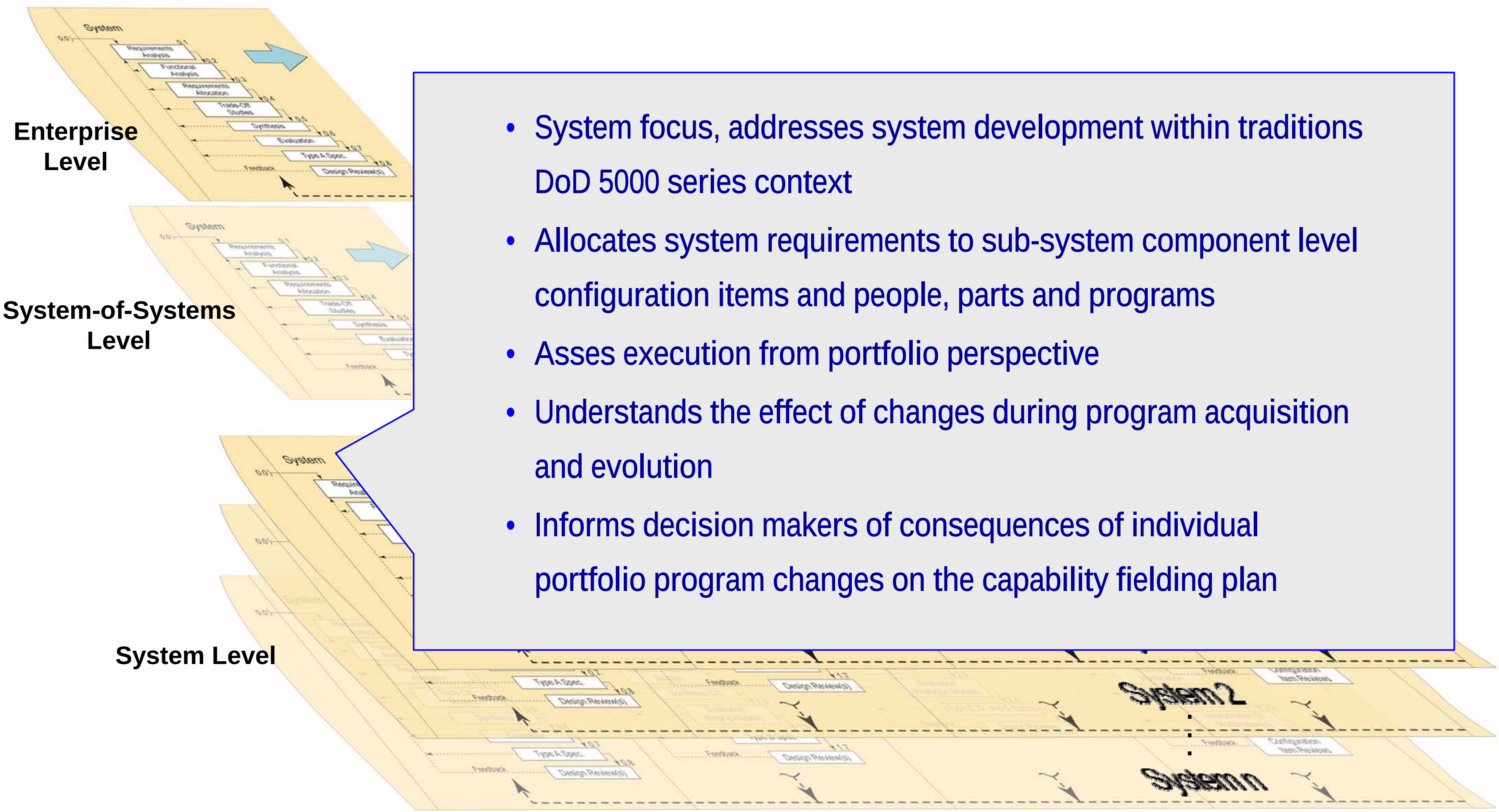
RDA CHIEF SYSTEMS ENGINEER

- ASW
  - Mission ⇨ Capability ⇨ SoS — RDA CHENG Engaged
- MIW
  - Mission ⇨ Capability ⇨ SoS — Starting to Engage
- SIAP
  - SoS ⇨ Capability ⇨ Mission — Engaging via SEP
- IAMD
  - SoS ⇨ Capability ⇨ Mission — Exploring

- *Leverage Army FCS SoS Plan*

RDA CHIEF SYSTEMS ENGINEER

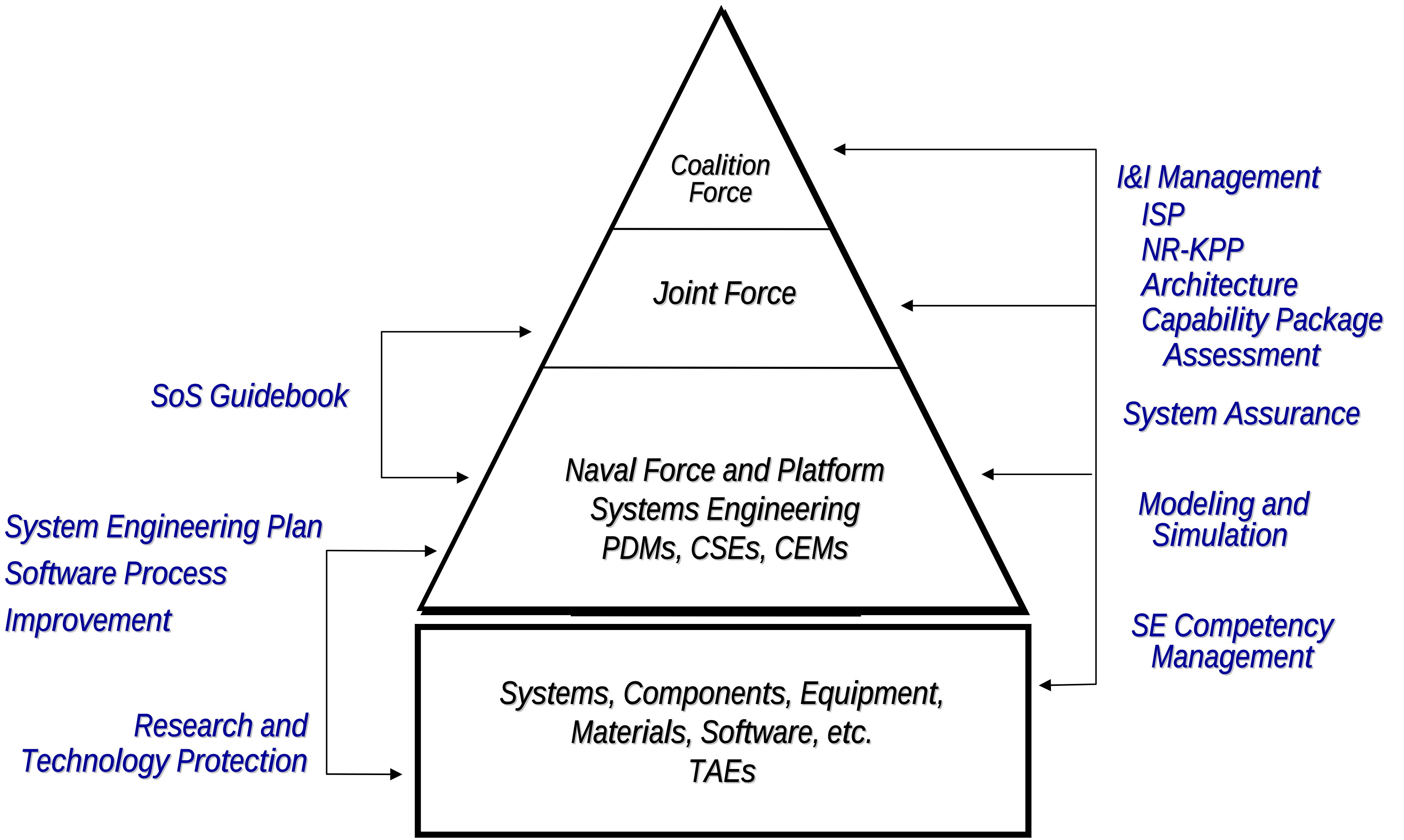
System Engineering: System Level



- System focus, addresses system development within traditions DoD 5000 series context
- Allocates system requirements to sub-system component level configuration items and people, parts and programs
- Asses execution from portfolio perspective
- Understands the effect of changes during program acquisition and evolution
- Informs decision makers of consequences of individual portfolio program changes on the capability fielding plan

RDA CHIEF SYSTEMS ENGINEER

Current Initiatives



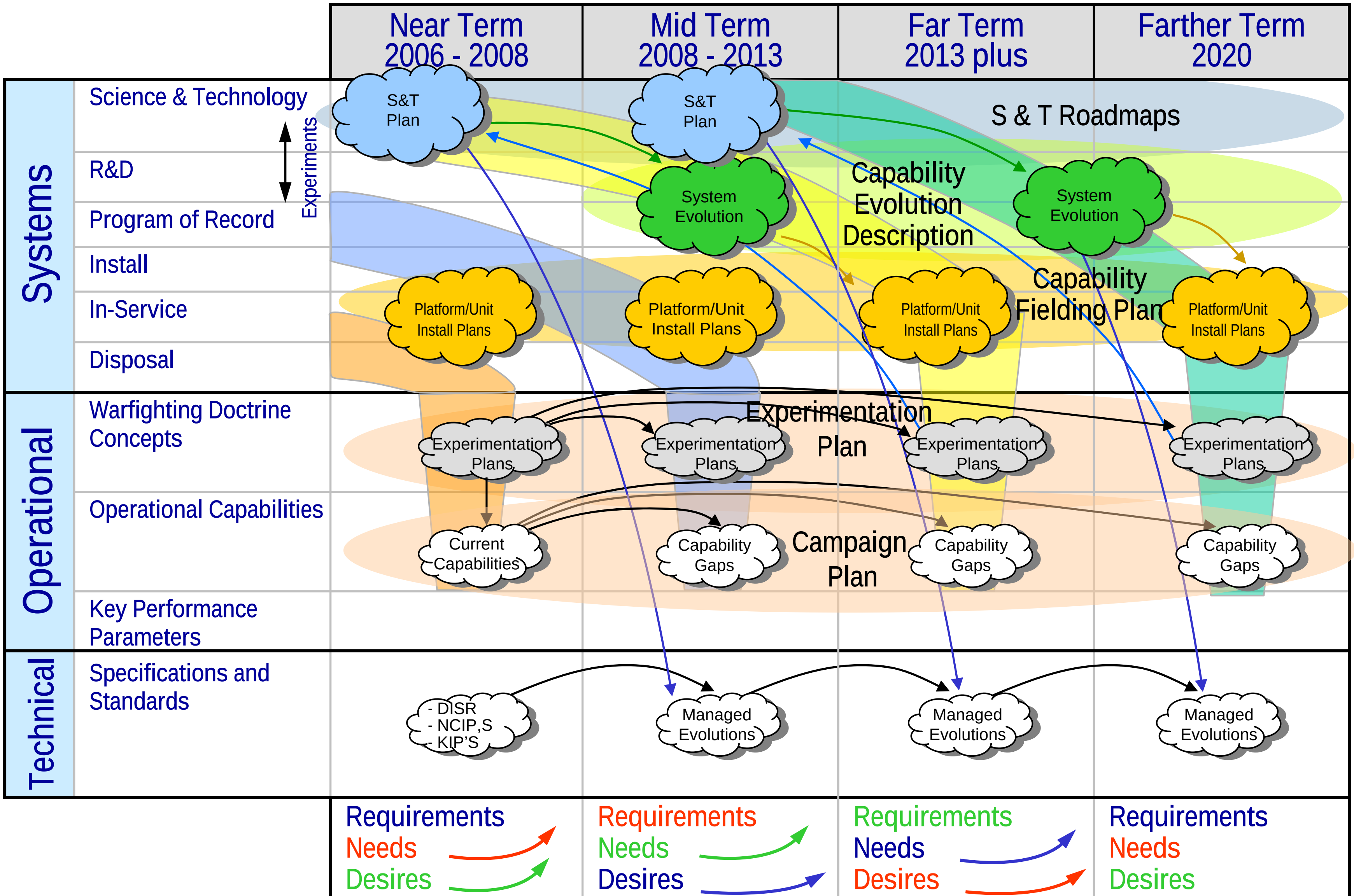
What is Needed?

- A good construct for Architecture
  - Capture of the “As-is”
  - Basis for the “Vision”
- Engineering processes, methods and tools that support the Enterprise and SoS levels
- Collaborative management tools for decisions
- Experienced Systems Engineers

Government /Industry Commitment to make it Happen

Capability Roadmapping

RDA CHIEF SYSTEMS ENGINEER



Test and Evaluation/ Science and Technology (T&E/S&T) Program

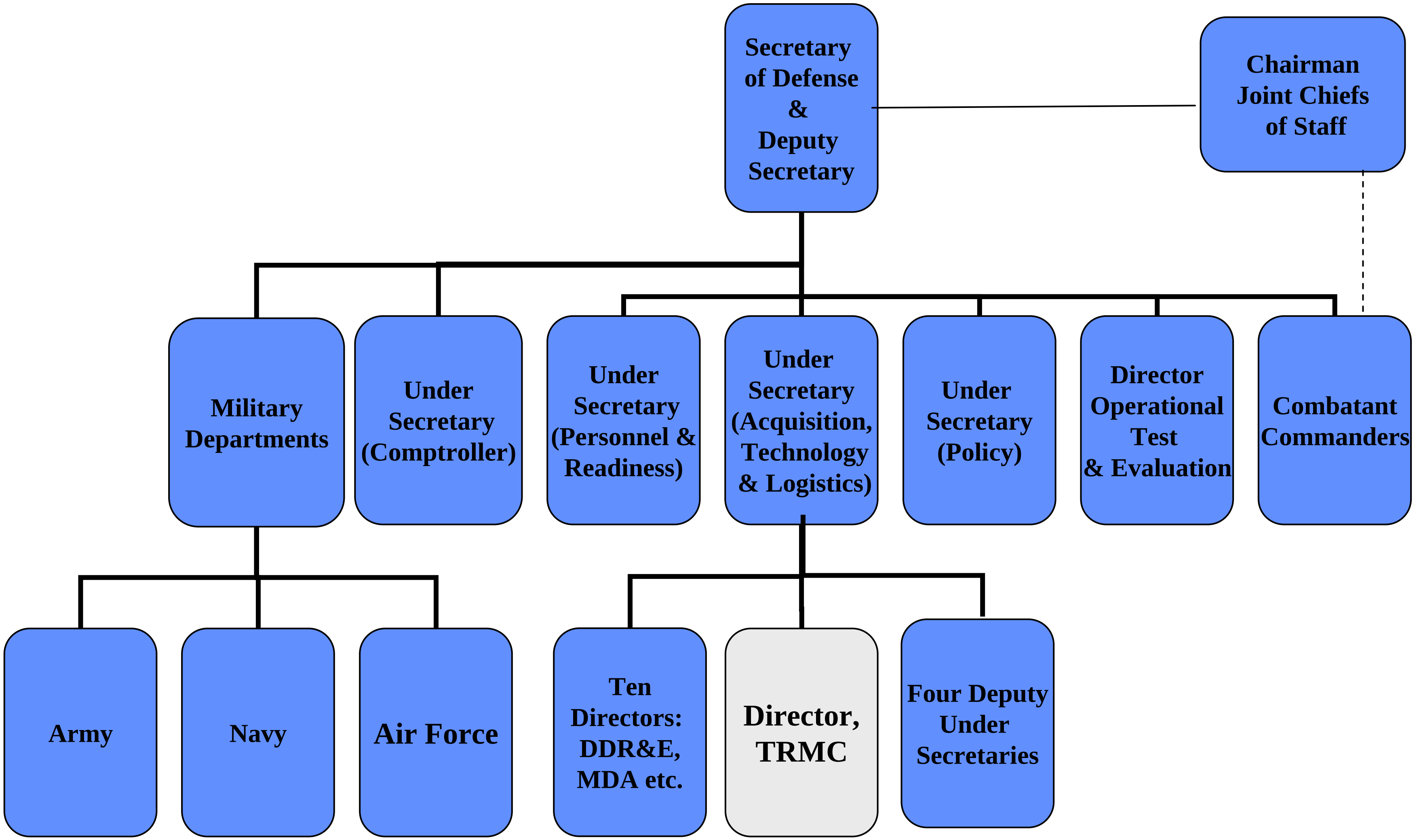
8th Annual Science & Engineering Technology Conference/DoD Technology Exposition
April 17-19, 2007

Mr. Derrick Hinton
T&E/S&T Program Manager
Test Resource Management Center
derrick.hinton2@osd.mil

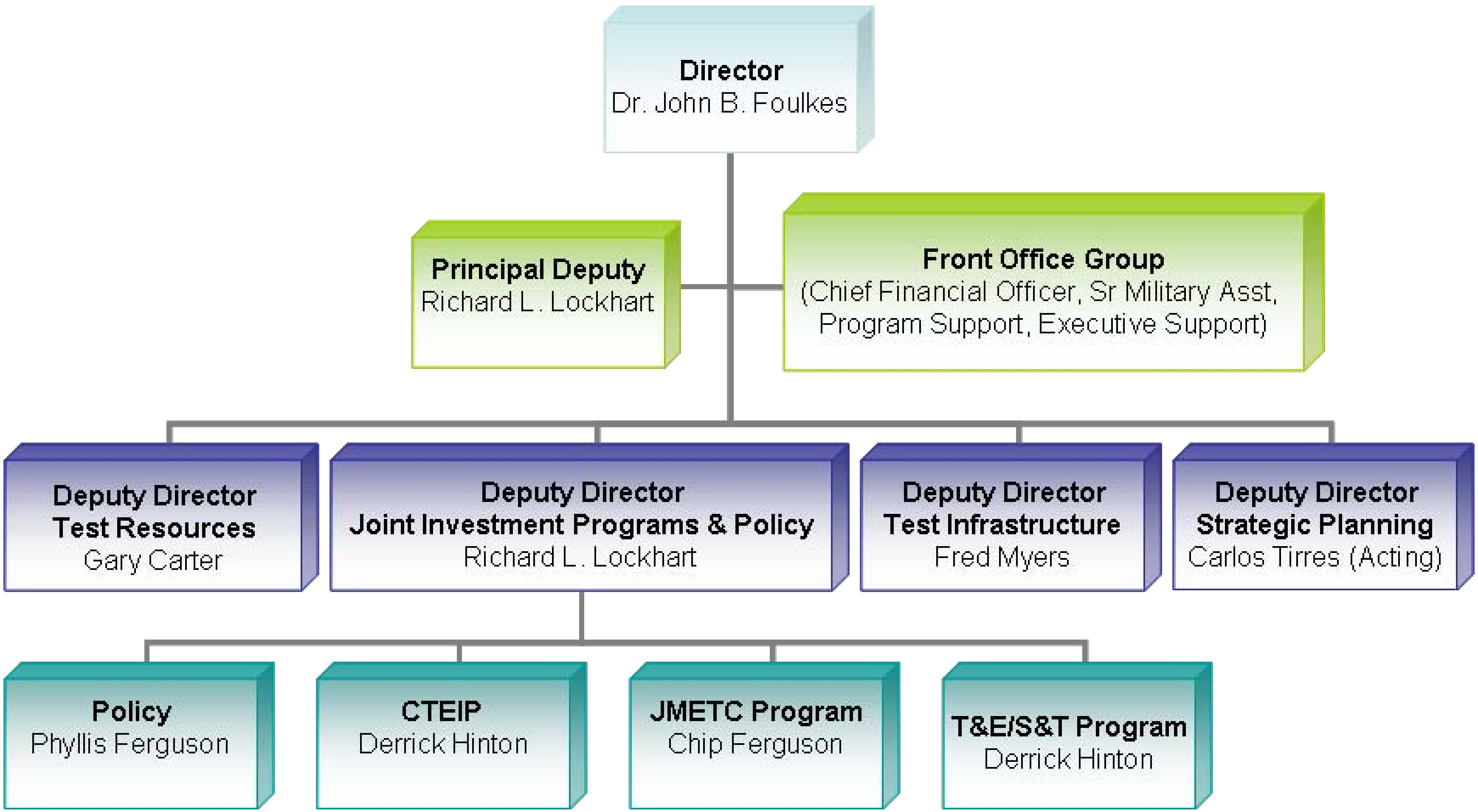
Test Resource Management Center (TRMC)
Sec. 231, FY 2003 National Defense Authorization Act
DoD Directive 5105.71, March 8, 2004

- **DoD Field Activity**
  - Established to ensure that the DoD T&E infrastructure is adequate to support the development and acquisition of defense systems
  - Led by Dr. John Foulkes, SES
    - Direct report to the Honorable Ken Krieg, Under Secretary of Defense (Acquisition Technology and Logistics)
- **Annually certify that the T&E budgets of the military departments and defense agencies are adequate**
- **Develop a biennial strategic plan that**
  - Assesses T&E requirements for a period of ten years
  - Identifies required T&E infrastructure investments
- **Responsible for all T&E infrastructure policy including DoD Directive 3200.11, Major Range and Test Facility Base (MRTFB)**
  - DODD 3200.11covers policy and responsibilities for the management and operation of MRTFBs
- **Administer three major T&E investment programs:**
  - Joint Mission Environment Test Capability Program (JMETC)
  - Central Test and Evaluation Investment Program (CTEIP)
  - Test and Evaluation/Science and Technology (T&E/S&T) Program

TRMC
Direct Report to USD(AT&L)



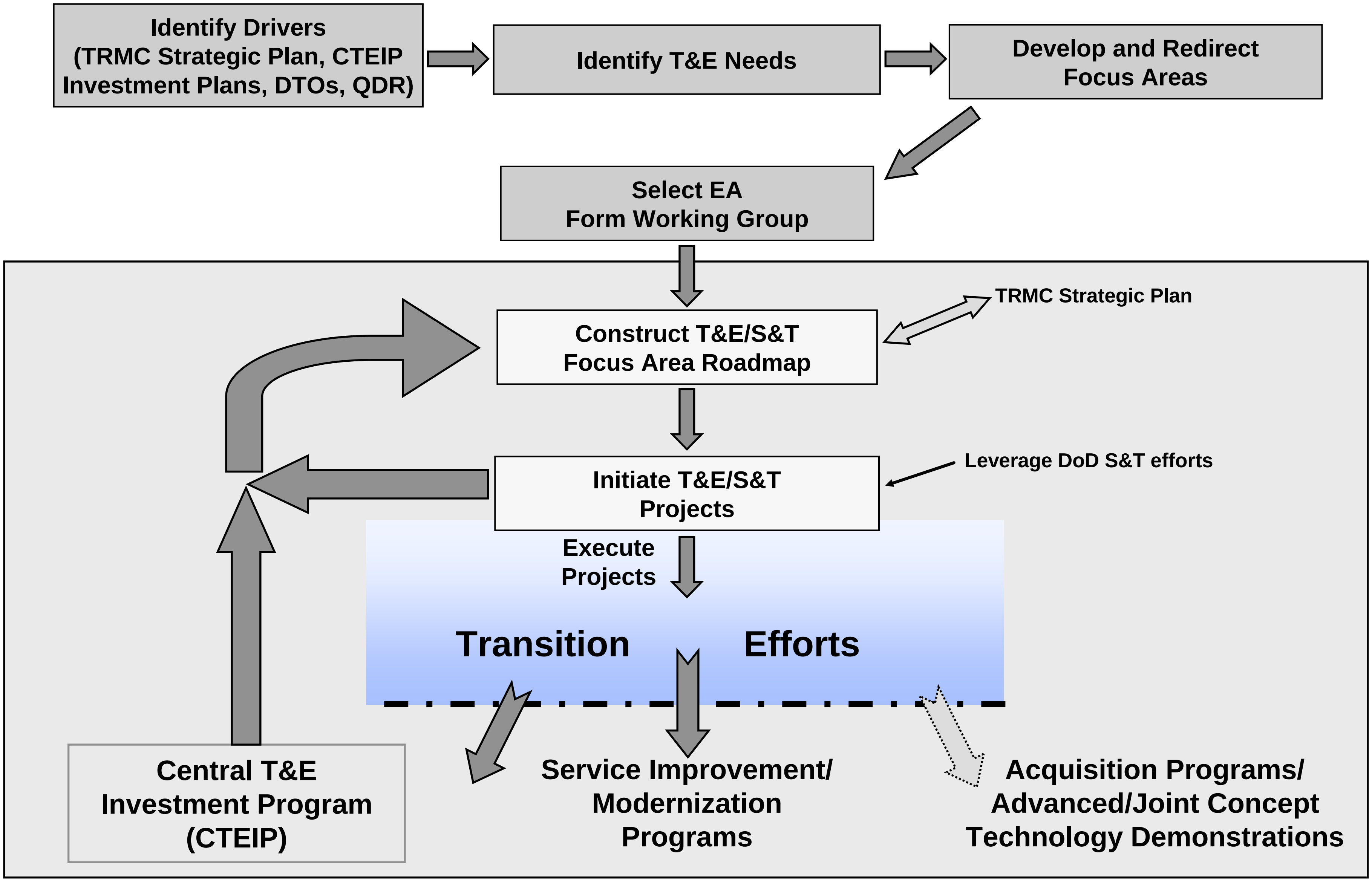
TRMC Organization Chart



T&E/S&T Program
Overview

- **Program started in FY 2002**
  - **Joint DDR&E / DOT&E initiative**
  - **Transitioned to TRMC in Feb 2005**
- **Mission**
  - **Investigate and develop new technologies required to test and evaluate our transforming military capabilities**
    - Includes any system that makes our warfighters more survivable and effective in combat
      - Lethal and non-lethal weapons
      - Intelligence surveillance and reconnaissance
      - Netcentric systems
- **Goal**
  - **Transition emerging technologies into test capabilities in time to verify warfighting performance**

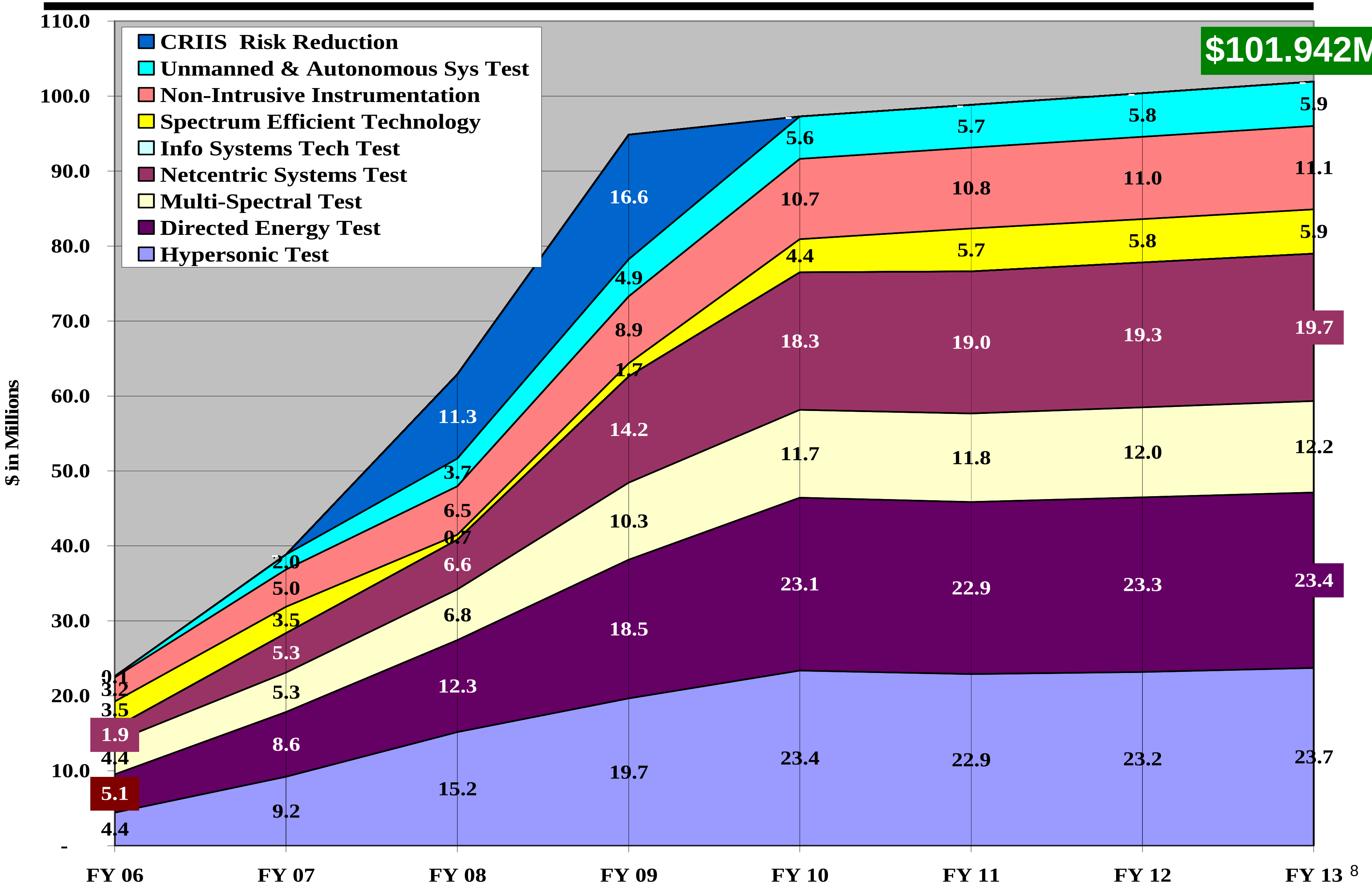
T&E/S&T Program Process



T&E/S&T Program Active Focus Areas

- **Test Technologies for**
  - Emerging Warfighting Capabilities
    - Hypersonic Vehicles
      - 14 active projects
    - Directed Energy Weapons
      - 17 active projects
    - Multi-Spectral / Hyper-Spectral Sensors
      - 10 active projects
    - Net-Centric Warfare Systems
      - 10 active projects
    - Unmanned and Autonomous Systems (FY06 Stand-Up, Evaluating Abstracts)
  - Enhanced Test Capabilities
    - Spectrum Efficient Technology
      - 11 active projects
    - Non-Intrusive Instrumentation
      - 13 active projects
  - 75 Active Projects

Test & Evaluation/Science & Technology
FY 2006 – 2013 Budget



T&E/S&T Program Structure

- **T&E/S&T Program Office**
  - D. Hinton (Acting Program Manager)
  - R. Barrett (Principal Engineer)
  - S. Arnold (Principal Scientist)
  - Support Staff

- **Hypersonic Test**
  - T. Fetterhoff (EA)
  - B. Phillips (Deputy)
  - Subj Matter Expert: J. Mitchell
  - Tri-Service Working Group

- **Netcentric Systems Test**
  - R. Heilman (EA)
  - G. Torres (Deputy)
  - Subj Matter Expert: *Various*
  - Tri-Service Working Group

- **Multi-Spectral Test**
  - F. Carlen (EA)
  - L. Huynh (Deputy)
  - Subj Matter Expert: S. Gontarek
  - Tri-Service Working Group

- **Directed Energy Test**
  - M. Vuong (EA)
  - A. Kapadia (Deputy)
  - Subj Matter Expert: *Various*
  - Tri-Service Working Group

- **Spectrum Efficient Technology**
  - S. Ortigoza (EA)
  - R. Streich (Deputy)
  - Subj Matter Expert: D. Schaefer
  - Tri-Service Working Group

- **Unmanned & Autonomous Systems Test**
  - F. Macias (EA)
  - Martin Rivas (Deputy)
  - Subj Matter Expert: *Various*
  - Tri-Service Working Group

- **Non-Intrusive Instrumentation**
  - G. Shoemaker (EA)
  - J. Hooper (Deputy)
  - Subj Matter Expert: S. Zakanycz
  - Tri-Service Working Group

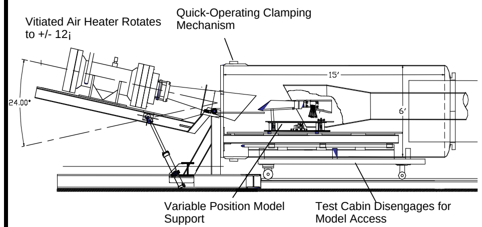
T&E/S&T Program

Technologies to Test Emerging Capabilities

Netcentric Systems Test

- Creating a Composable, Distributed Live-Virtual-Constructive Test Environment
- T&E of Service Oriented Architectures
- Information Assurance (IA) Testing
- Test Environment Control and Situational Awareness

High Speed/Hypersonic Test



- Variable Mach test capabilities
- Clean air heaters
- Heat flux sensors
- Combustion gas analysis
- Advanced computational fluid dynamics
- Measurement of high pressure, temperature, and shear stress
- Technologies to determine effects of vitiates

Directed Energy Test

- Measuring the effects of Directed Energy on the target
- Survivable on-board instrumentation
- Instrumentation on targets that is non-intrusive to performance and threat signature
- Instrumentation to determine performance margins
- Evidence of the degree of hard kill and soft kill
- Emulating far-field effects in near-field conditions

Multi-Spectral Test

- Simultaneous generation and injection of RF, UV, visible and IR bands
- Wide-range, dynamic scene projectors with fast frame rates in step with next-generation focal plane array sensors and seekers
- Hi-fidelity simulations to create realistic scenes
- Affordable processors to run hi-fidelity simulations
- End-to-end multi-spectral test capability

T&E/S&T Program
Technologies to Test Emerging Capabilities

Unmanned and Autonomous Systems Test

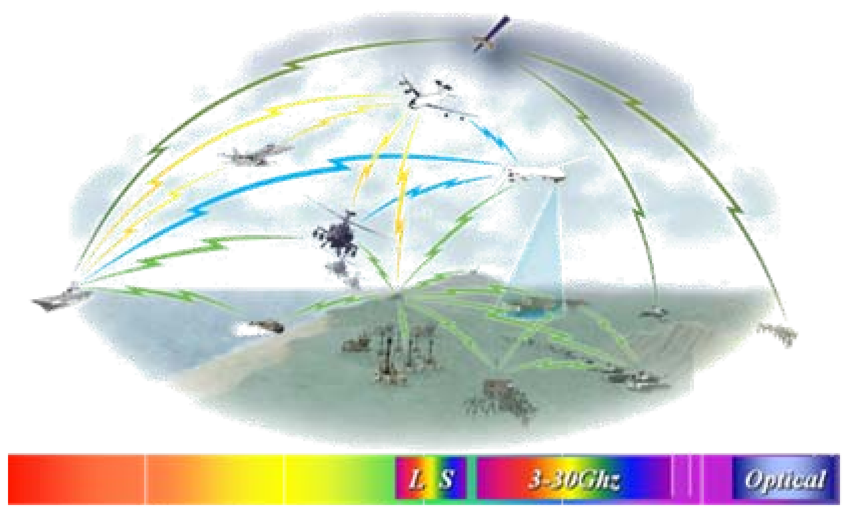
- **Unmanned and Autonomous Systems are emerging weapon systems**
  - **Limited ability to test**
- **Established new focus area in FY06**
  - Develop technologies required to support T&E of Unmanned and Autonomous Systems
  - Leverage efforts in DoD, academia and industry to ensure test ranges can support testing of adaptive, learning systems

- **Developing detailed roadmap to identify T&E Gaps**
  - **Link efforts with Unmanned and Autonomous System technology developers**
  - **Work closely with T&E ranges to identify critical shortfalls**

- **Will address technical challenges in this area including (but not limited to):**
  - **T&E of cognitive functions**
  - **Ability to test/control unmanned systems in an unscripted scenario environment**

- **Broad Agency Announcement issued Dec 06**
  - Requesting 21 proposals based on the 56 white papers submitted

T&E/S&T Program
Technologies for Enhanced Test Capabilities

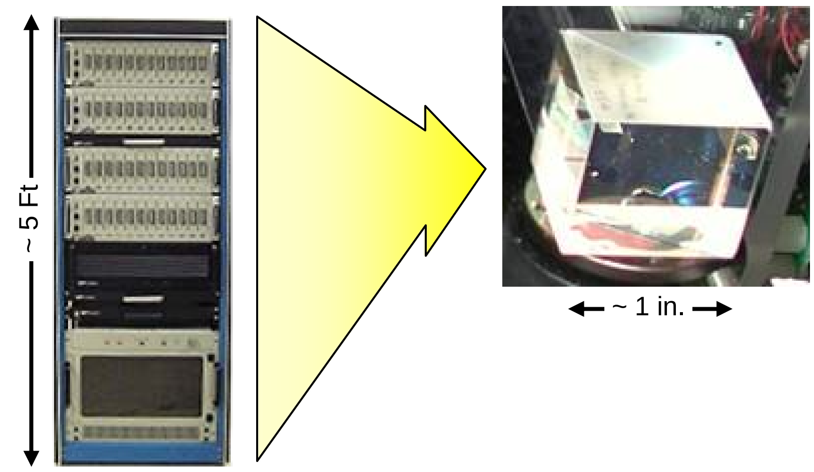


Spectrum Efficient Technology

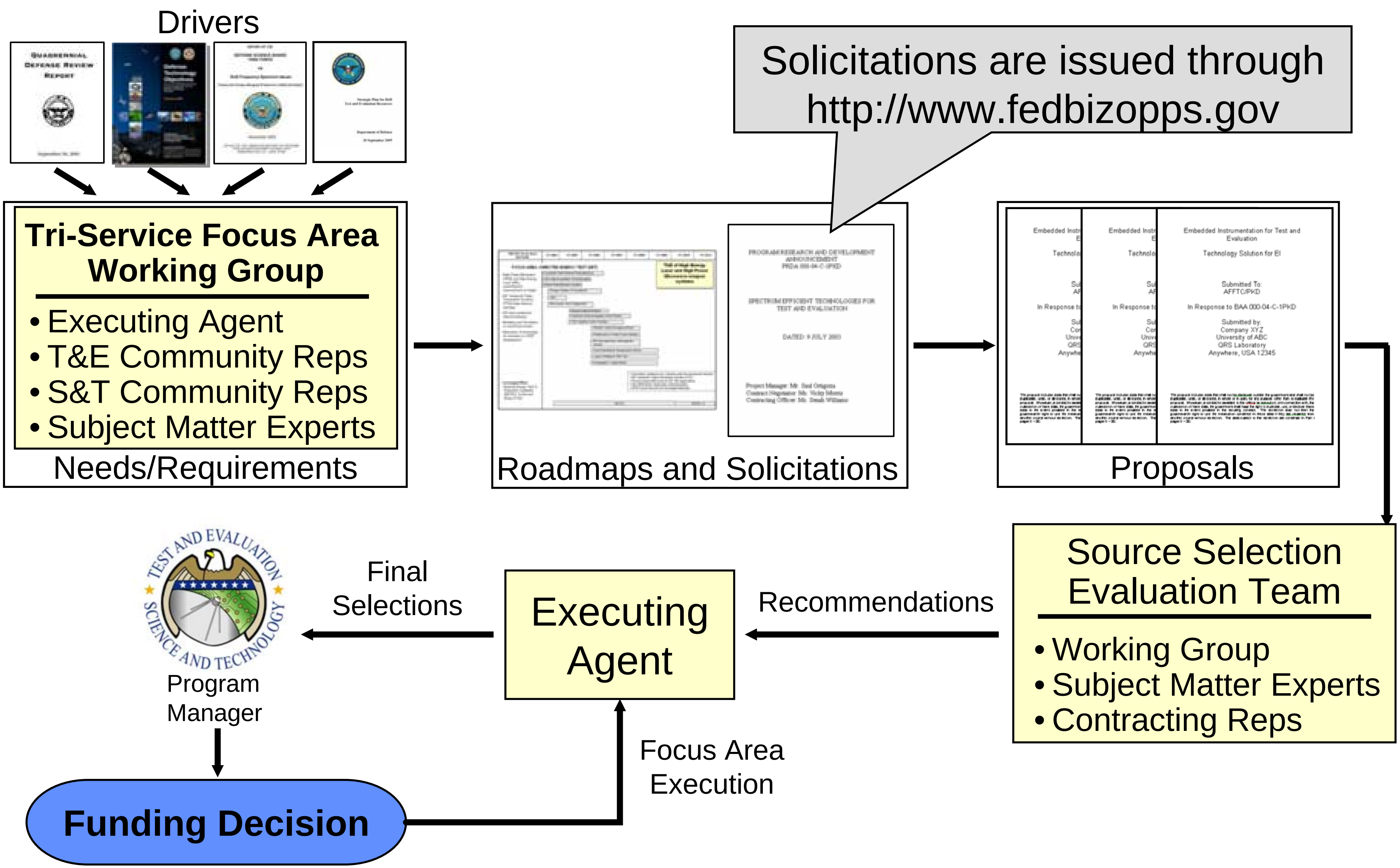
- Spectrally-efficient, high data rate telemetry
- Steerable beam, directional antenna technologies
- Microelectromechanical Systems (MEMS) antennas
- Advanced modulation and compression techniques
- High dynamic wireless networking capabilities
- Software radios & efficient waveforms
- Use of non-traditional telemetry bands – Super High Frequency and Optical

Non-Intrusive Instrumentation

- Non-intrusive, integrated, miniaturized instrumentation
- MEMS sensors and nanotechnology
- Compact, highly-reliable, high-density data storage
- Efficient, independent power sources
- Open, modular architectures for "plug and play" assembly of components
- Enhanced survivability through improved materials and packaging techniques
- Applicable across the acquisition process as well as to training and logistics



T&E/S&T Program
Project Selection Process



Success Criteria

- Technology Success: Demonstration of new test technology

- Capability Success: A test technology is incorporated into a test capability

- Testing Success: A test program has benefited from using the test technology

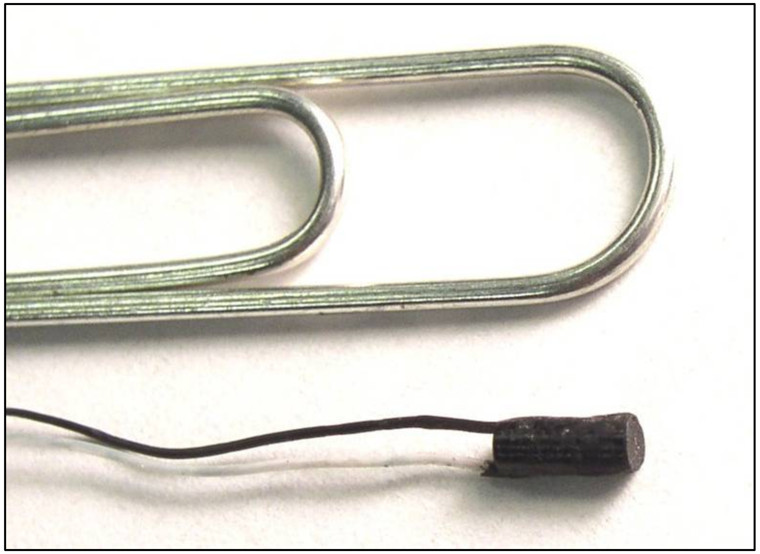
Heat Flux Sensor Development for Hypersonic Aerothermal Measurements

–High Speed/*Hypersonic Test*–

Developing miniaturized heat flux sensors with the following performance characteristics:

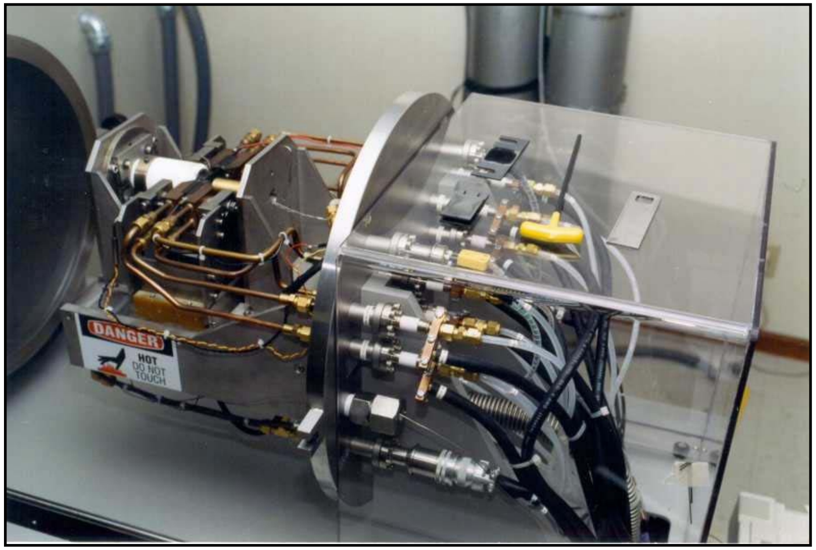
- Continuous operation at 700° F
- Calibration to 50 Btu/ft^2-sec
- 0.0625 inches in diameter
- Compatible with embedding in Systems Under Test

Testing Success



0.0625 inch diameter heat flux sensor prototype

Calibration unit



Used to support NASA Shuttle Return to Flight and MDA Kinetic Energy Interceptor tests

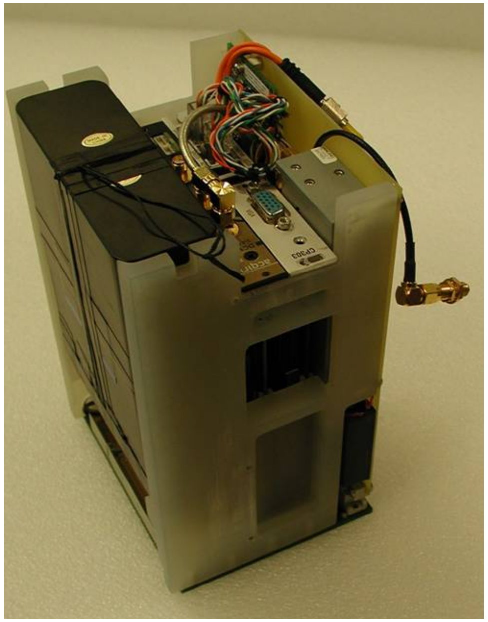
Directed Energy Data Acquisition Transformation

–Directed Energy Test–

- Developed a HPM hardened Compact Remote Data Acquisition System (CRDAQ) to replace analog Fiber Optic transmitters and oscilloscopes
  - Eliminates high-maintenance analog fiber optic links
  - 10-bit resolution increases dynamic range from 32 dB to over 40 dB
  - Automatic built-in calibration
  - 110 dB total dynamic range
  - Overall dimensions: 8.375” x 4.75” x 5.25”
- Developed simultaneous trigger and a breadboard 3-axis probe for HPM testing

Testing Success

CRDAQ Subassembly



Prototype CRDAQ

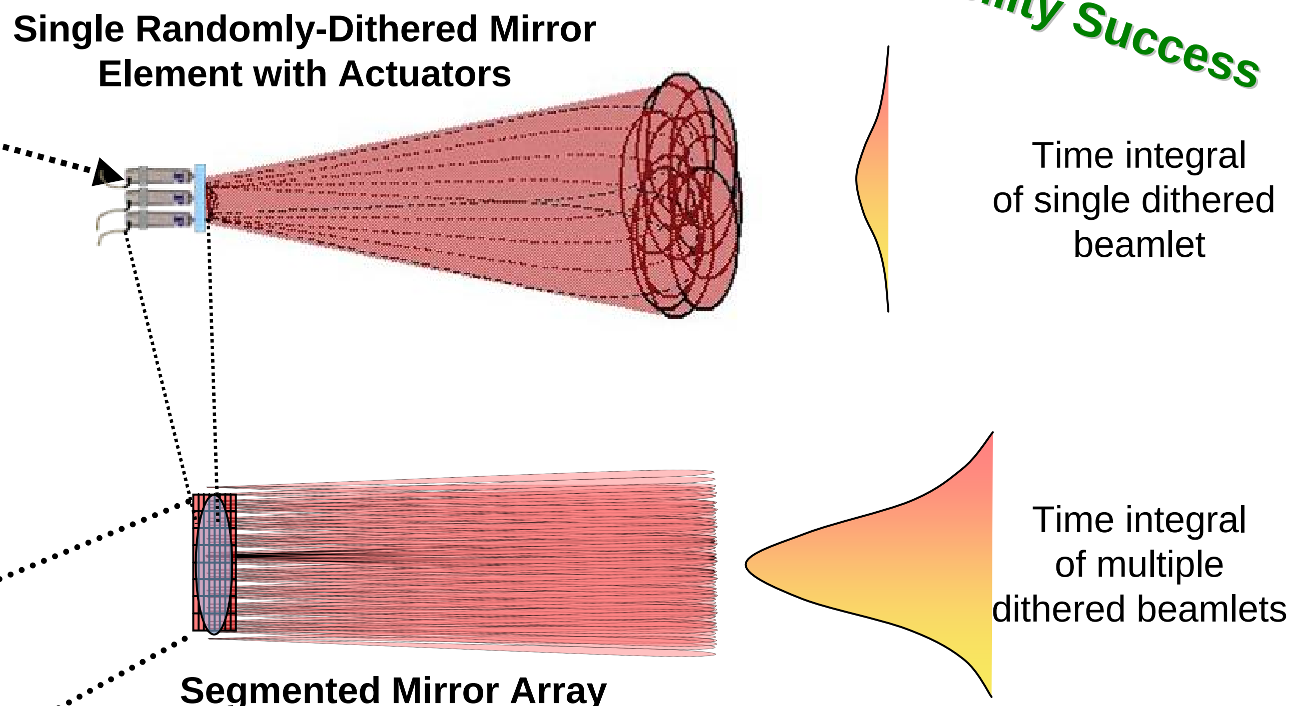
CRDAQ with open top

Used to support multiple HPM tests at NSWC Dahlgren Division

Beam Redistribution System

–Directed Energy Test–

Capability Success



- **Developed segmented mirror array composed of individual randomly dithered mirrors**
  - **Multiple mirrors can achieve integration times that are short compared with the target thermal time constant**
- **Allows Far-Field laser testing to be conducted in Near-Field test environment**

Transitioned to the CTEIP Directed Energy Test and Evaluation Capability (DETEC) Project

Compact Holographic Data Storage

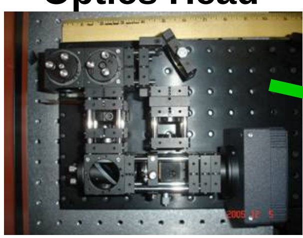
–Non-Intrusive Instrumentation–

Developed a brassboard compact holographic memory package that will support high-density, high-rate data recording—no moving parts. Brassboard system demonstrated:

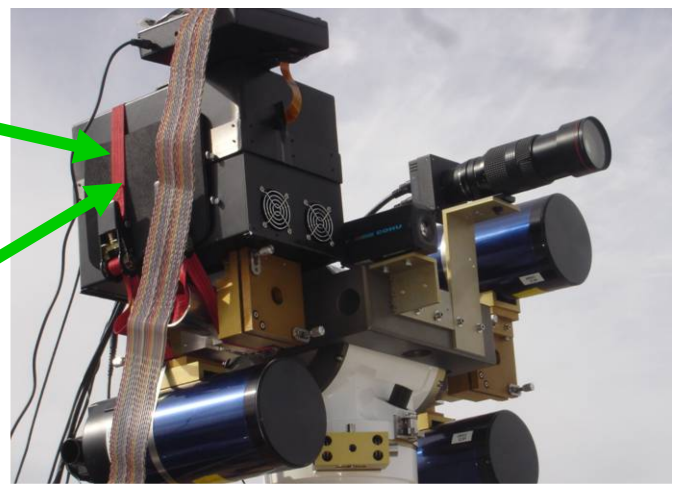
- Storage density = 767 Gigabytes
- Bit Error Rate = 1 x 10^{-9}
- Writing transfer rate = 1 Gigabits/sec
- Reading transfer rate = 1 Gigabits/sec

Technology Success

Optics Head



Blue diode laser source



Holographic Memory Data Storage brassboard on tracking mount

Reconstructed stored images

Used to store imagery from Multiple Launch Rocket System tests during WSMR test event

T&E/S&T Program
Wrap Up

- **T&E/S&T program initiated to address critical T&E needs, tied to S&T drivers**
- **Sustained growth and demonstrated value**
  - Mature focus areas transitioning technology into test capabilities
- **Keys to continued success**
  - Participation of Services on Joint needs definition
  - Good mix of industry, laboratories and universities working on solutions
  - Participation of Services, industry, laboratories and universities to transition technologies to T&E capabilities

Shaping Technology into Tomorrow's T&E Capabilities

NORTHROP GRUMMAN

DEFINING THE FUTURE

Workforce Issues

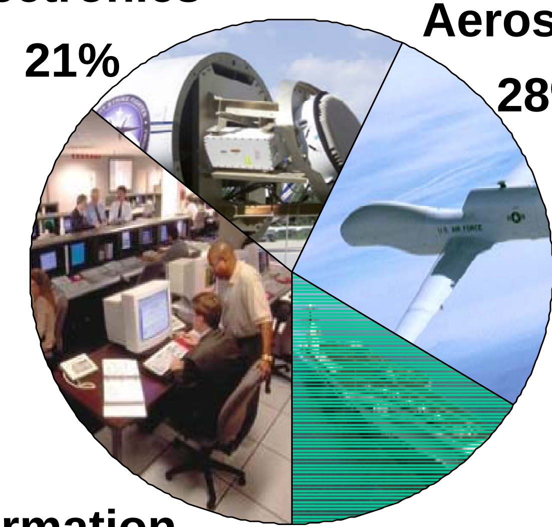
Address to 8th NDIA Annual Science and Engineering Technology Conference

March 27, 2007

Ed Swallow
Sector Vice President, Strategic Capture and Campaigns
Northrop Grumman Corporation

Northrop Grumman: A National Security Powerhouse

- **One of top three U.S. defense contractors**
- **One of two top IT providers to the U.S. government**
- **Leading IT systems integrator & information security provider**
- **Largest military shipbuilder**
- **Largest provider of airborne radar & electronic warfare systems**
- **One of three major contractors in military & civil space, missile defense**
- **Leading capabilities in:**
  - C^4ISR and battle management
  - Information technology and networks



\$30.7 Billion **50 States** **25 Countries** **120,000 Employees**

Copyright 2007 Northrop Grumman Corporation

Example of Globalization–
US Firm Sponsors Non-US Technology

Northrop Wins $874M USPS Automation Deal

By William Welsh, Washington Technology, 03/-1/2007

Northrop Grumman **Corp. won an $874.6 million contract from the U.S. Postal Service to provide technology that will further automate mail processing. Under the contract,** Northrop Grumman **will provide 100 flats sequencing systems that further automate the flats mail stream. The flats mail stream includes large envelopes, catalogs and magazines. Installation of the first flats sequencing systems is scheduled to begin in 2008. The company will complete the remaining installations by 2010. The Los Angeles-based contractor's first generation of flats sorting technologies is in operation at Postal Services processing center nationwide. The flats sequencing systems represents the next generation of flats automation by sorting mail to the delivery sequence of each carrier, thus reducing manual sorting. Flat mail is a labor intensive category of mail to process and deliver due to variations in size and thickness. Northrop Grumman developed the technology in conjunction with Solystic of Gentilly, France, and Siemens Energy and Automation of Arlington, Texas.**

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Example of Globalization
Non-US Government Sales by US Company

- **Through Life Support for the E-3D Sentry Aircraft**
- **Sentry IPT forward vision**
  - Availability based whole life support
  - Predictable cost “Power by the hour”
  - Integrated support arrangement for all subsystems
  - Partnering
    - Customer to team – High levels of empowerment
    - Prime to team – Encouraging “right” behavior
    - Small Business role
      - Customer intimacy

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Workforce Issues

Results of the DDR&E/NDIA Workforce Study

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NORTHROP GRUMMAN

DEFINING THE FUTURE

Technical Workforce Issues

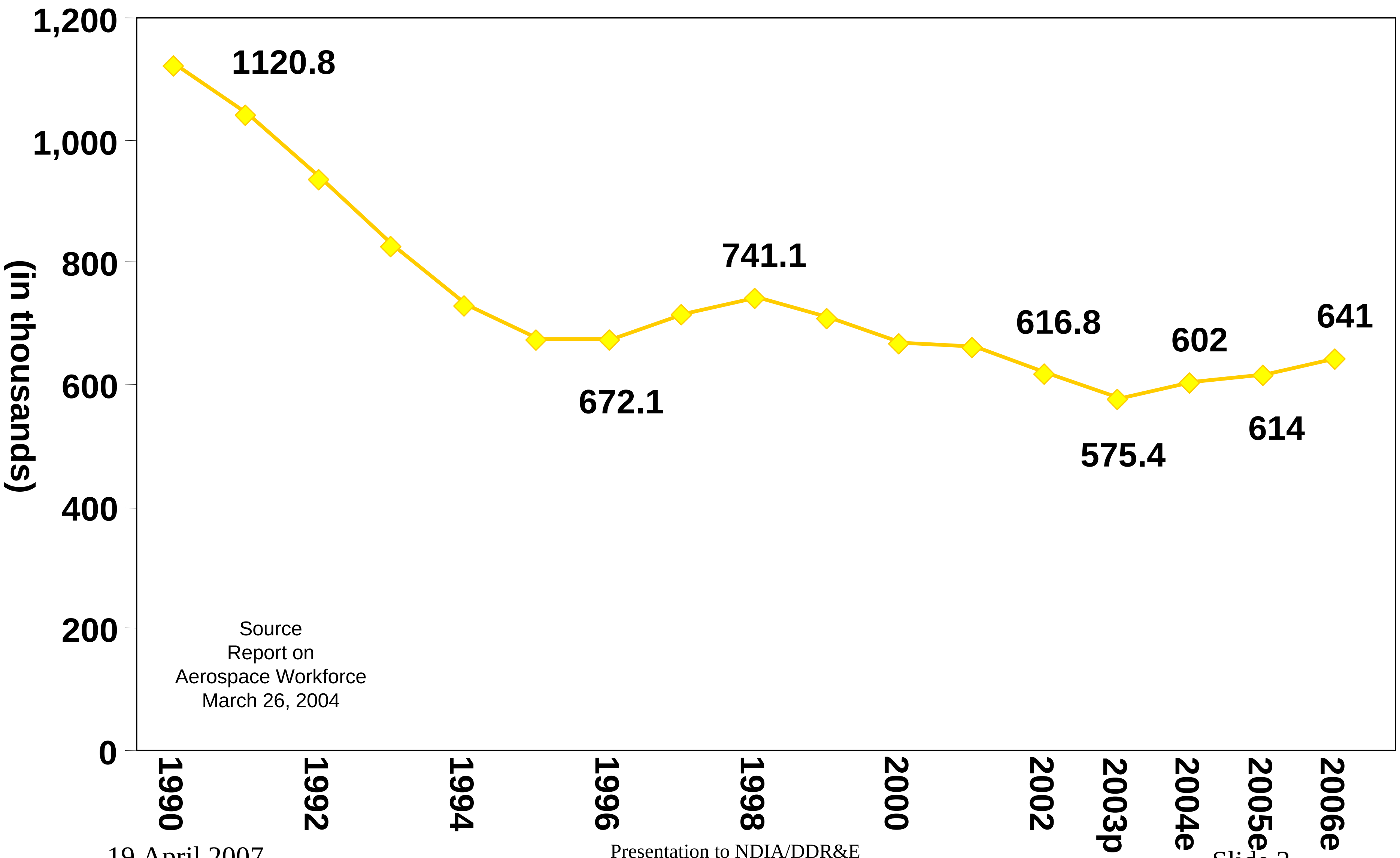
Edward Swallow
NDIA National Security Science and Technology Workforce Division Chair

Northrop Grumman

Objectives

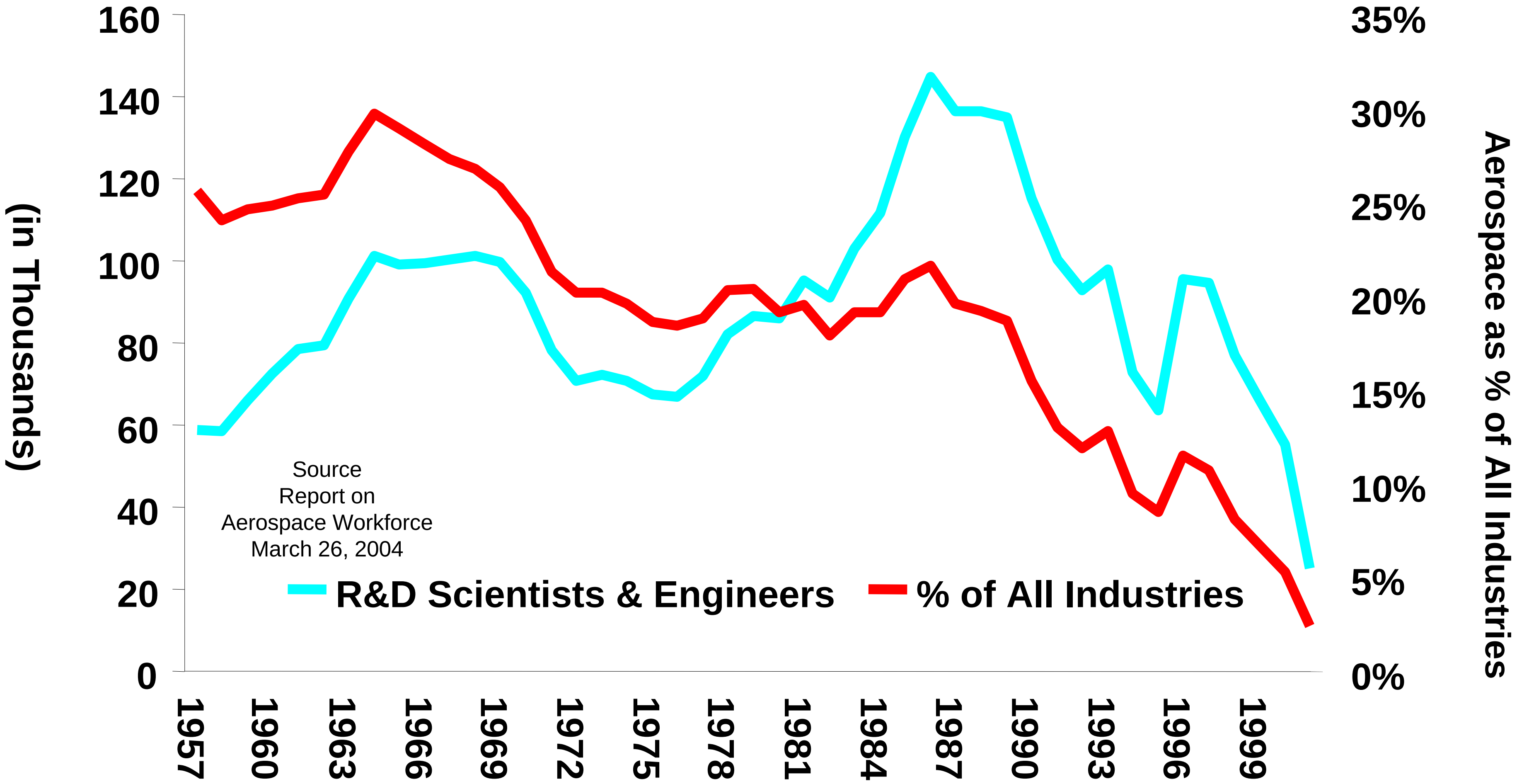
- Is there a workforce issue within Aerospace & Defense (A&D) Workforce?
  - Specifically looking at cleared or clearable Science, Technology, Engineering and Mathematics (STEM) professionals
- What are the demand drivers within that workforce?
- What is Industry doing about it?

"Aerospace" Employment



R&D Scientists & Engineers Employment

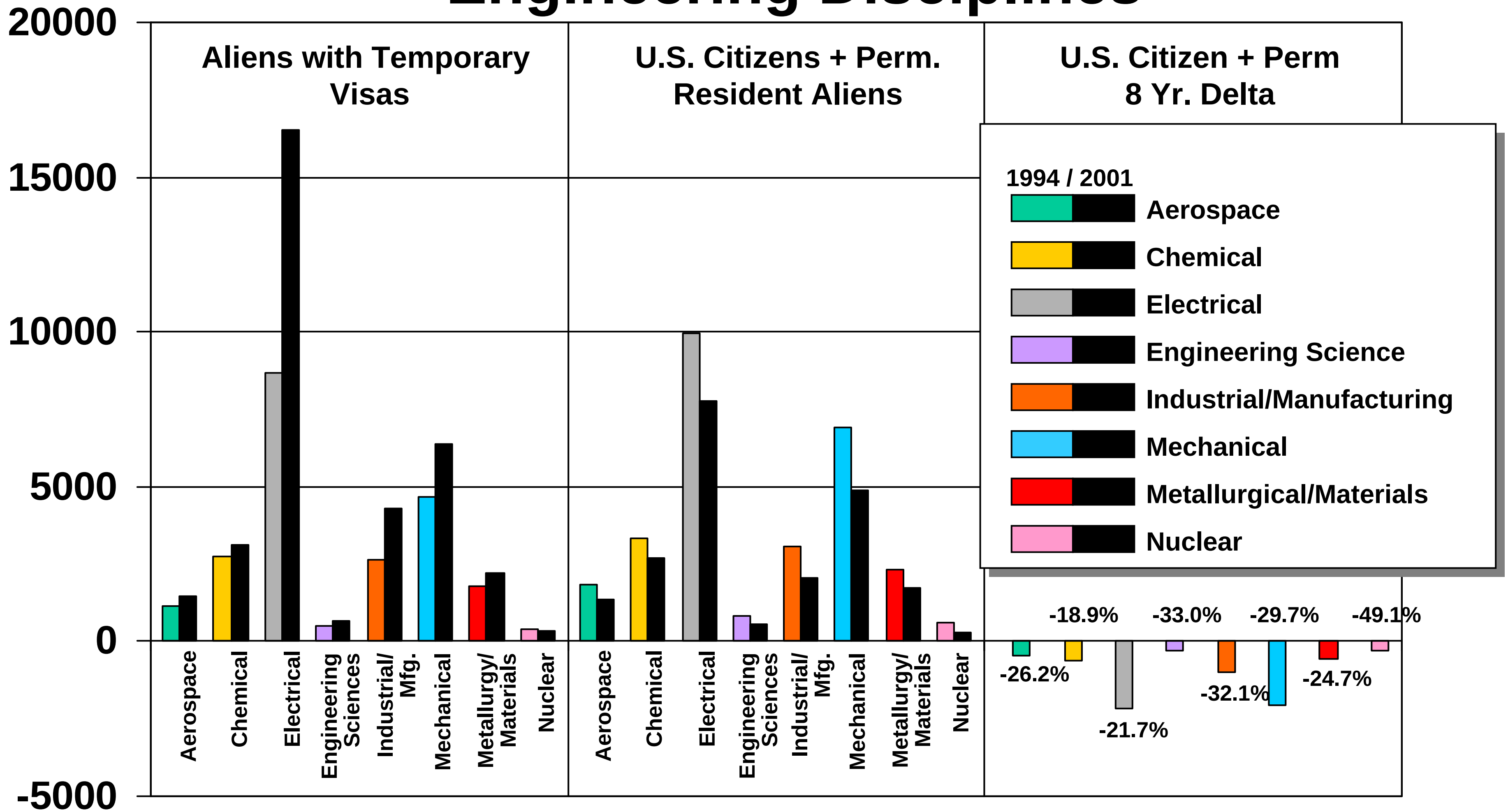
in Aerospace and as Percentage of all Industries



U.S. University Trends in Defense-Related S&E
Graduate Student Enrollment (1994-2001)

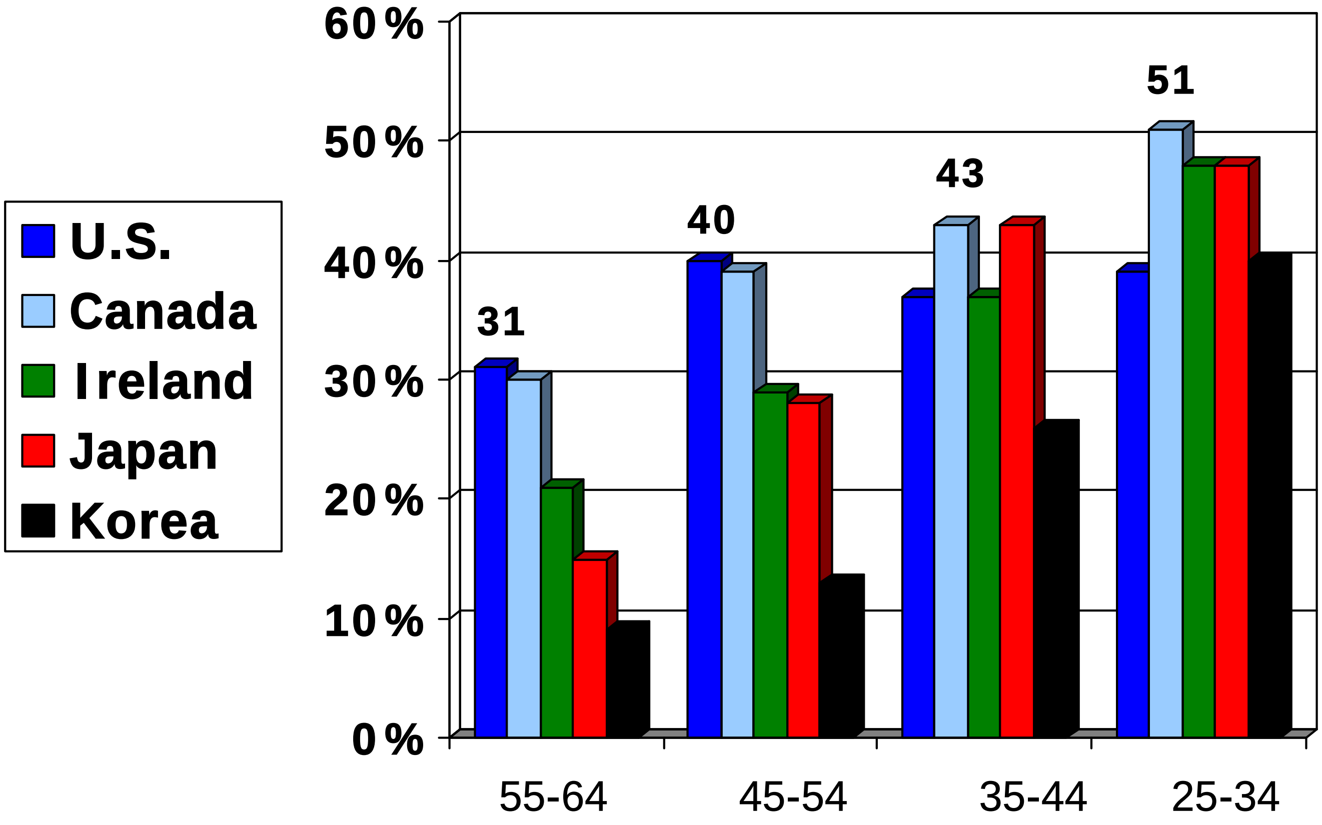
***Source: National Science Foundation – Graduate Students and Post Doctorates in Science and Engineering: Fall 2001**

Engineering Disciplines



Percentage of population with a postsecondary credential

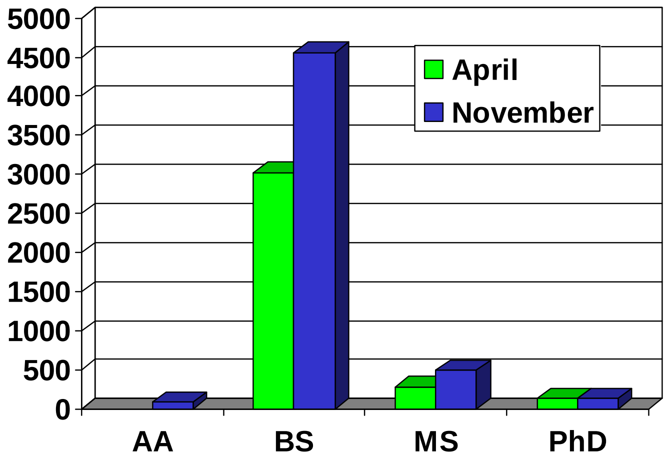
Losing Our Edge?

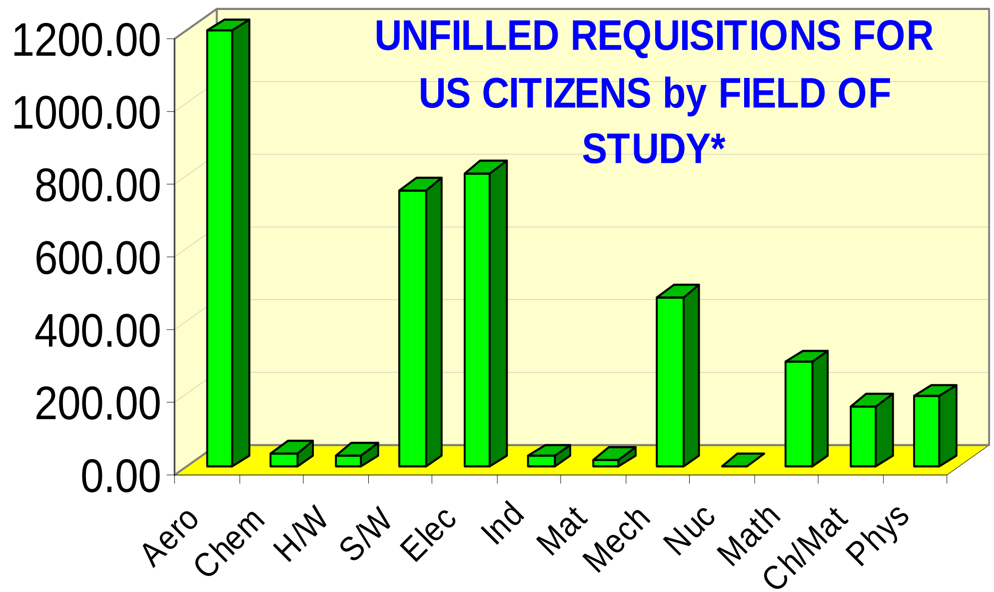


Education at a Glance: OECD Indicators 2003

2004 Surveys

Unfilled, Funded Requisitions By Degree Level

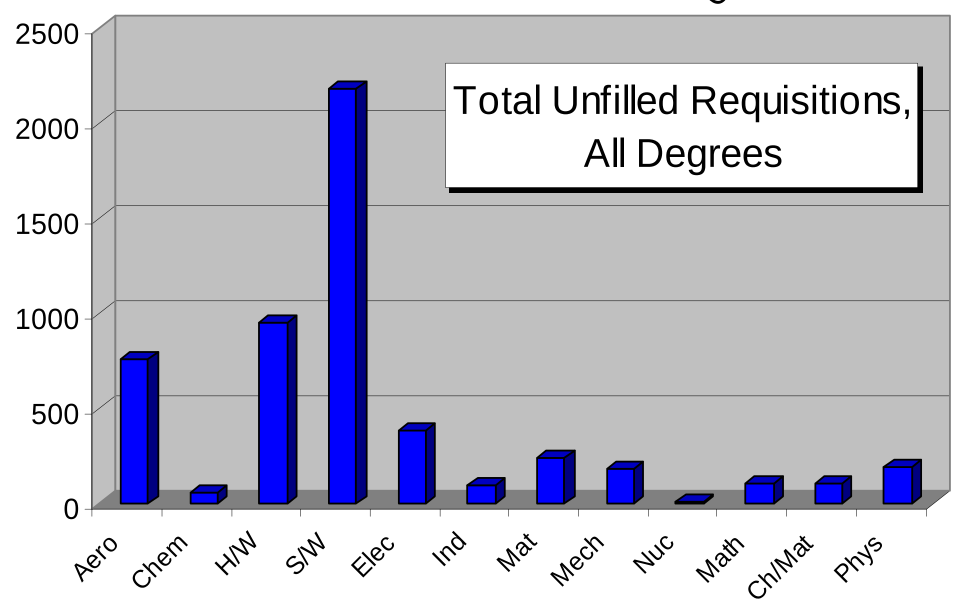




Note: includes only data from respondents to NDIA/AIA Survey

No extrapolation taken to total population

No normalization of data between surveys except question consistency



Defense Industry Perspective

Quick-Look Presentation
August 31, 2004

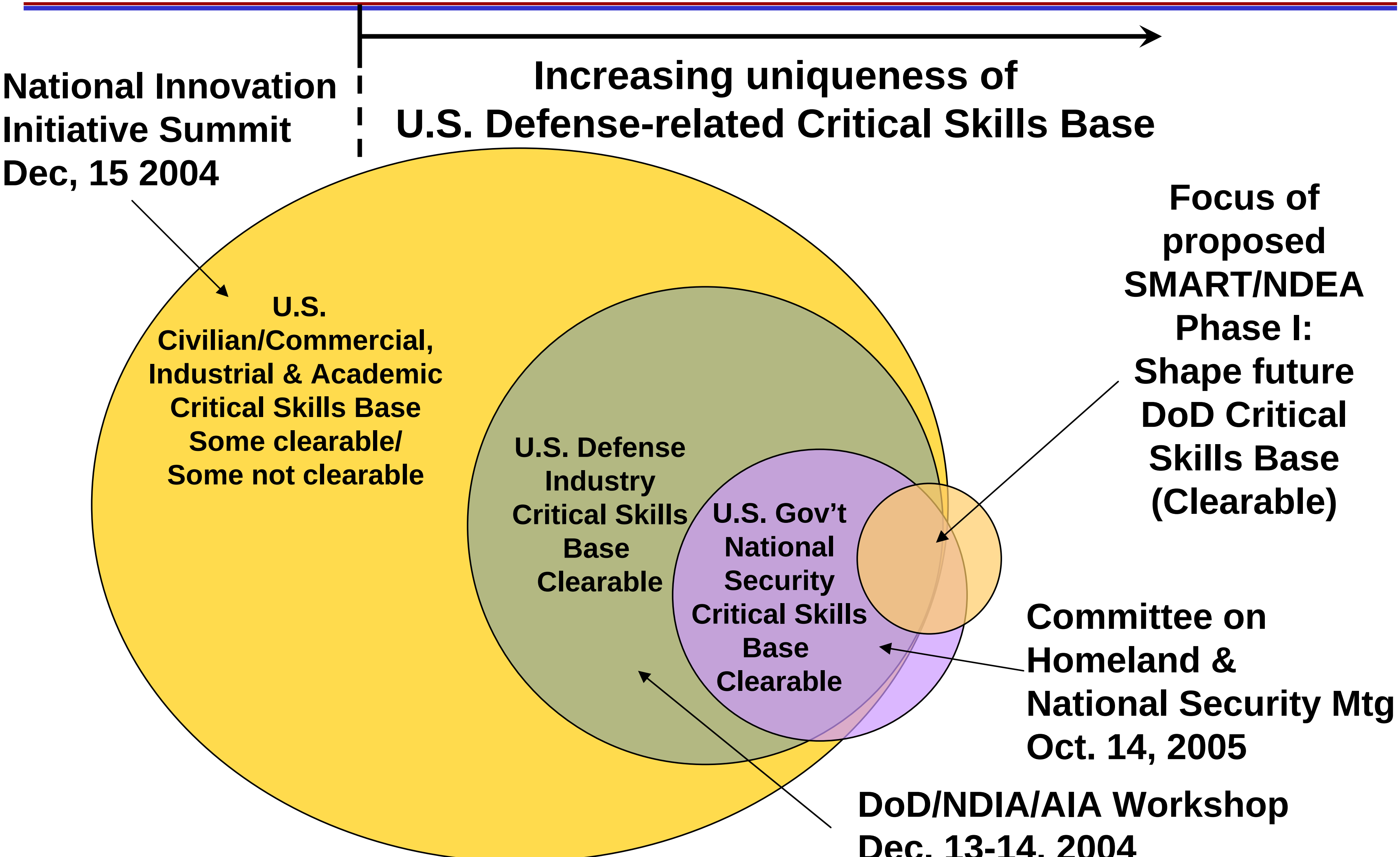
Report on
Aerospace Workforce
March 26, 2004

- Industry Demand Data
  - Survey responses highly indicative of a high demand/low supply market place with future negative trends for US Citizens
- Workforce Demand Thematic
  - Perfect Storm Analogy is real – not just anecdotal
  - Focused on cleared and clearable engineers
- Employment Considerations
  - Priming the pump is only first step – effective utilization and retention are critical!

- Immediately reverse the decline in scientifically and technologically trained US workforce…
- America's breakdown of intellectual and industrial capacity threatens national security and our capability to continue as a world leader
- Substantive, long-term US Gov. investment in STEM education and training at the undergraduate and graduate levels

Initial DoD Critical Skills Focus

Proposed SMART/NDEA Phase 1 Relative to Other U.S. Sectors



Workforce Demand Thematics

- SEE – Significant Emotional Event (or Significant Technological Event) for change in demand is mismatched with supply
  - Sputnik – NDEA 58
  - Invention of the integrated circuit – Led by DARPA investments
  - Personal (Distributed) Computing explosion -- System integration capabilities drawn from DOD experience
  - Internet -- ARPANET

- Weather prediction – Perfect Storm appears to be forming from unprecedented conjunction of trends
  - Retirement of the post-Sputnik generation
  - Decline in clearance-eligible S&E workforce
  - Diminishing U.S. technological dominance due to globalization of R&D

There is no assurance that we can maintain our technological advantage for next/follow-on generation operational capabilities

Demand Model Considerations

- Industry “follows the money” and “mirrors” the government
- Not clear what will and can be expected of industry versus what will be done in the government (SoS work, lab demise, etc)
  - Industry’s strategic planning window is about 8-20 quarters
    - DoD planning is 5-10-20 years (firm 1-2, less firm 3-10)
    - Academia basic research focused
  - Industry IR&D commitment currently near-term focused
    - Risk reduction vice innovation
  - Government may have unrealistic expectations that industry will pick up what the government is shedding
  - Technology application skills are not the same as tech base R&D
- Flexibility to deal with:
  - Technology trends/surprises
  - Doctrinal and vision changes
  - Uncertain budgets/commitments and changing procurement cycles

What Are We Doing About It?

(And what can you do?)

Recent DoD Activities

- SMART/National Defense Education Act (NDEA) Phase I
  - Funded at $4M for FY06, $14M for FY07 and $40M for FY08
  - Phase I program details in active coordination
- Future actions
  - Establish mechanism to refine critical skills & disciplines needs
  - Improve reporting of ongoing programs
  - Track Science, Mathematics, and Engineering (SME) participants
- Establish Industry organization for enduring response
  - AIA Industrial Base and Workforce Committee
  - NDIA National Security Science and Technology Workforce Division

NDEA Initiatives Matched to the Strategy

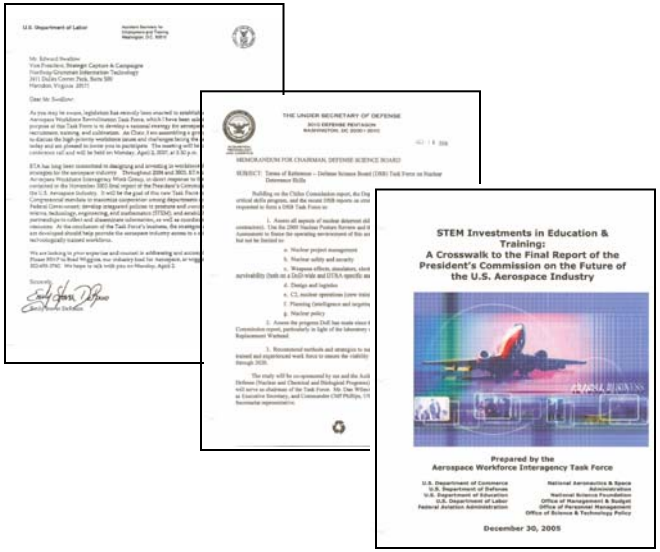
Supply			Demand	
K-12	High School & Undergraduate	Undergraduate & Graduate	Undergraduate & Graduate	Postgraduate
Excite	Attract	Educate (& Assist)	Recruit	Retain (& Continue to Educate)
Student Enrichment Programs (STARBASE, grades 5-8)	Secondary School Research Exposure and Experiences	National Defense Undergraduate Scholarship Program	Defense Undergraduate Internship Program	Joint Capabilities Focused Postdoctoral Fellowships Program
Modeling and Simulation Based Math Curriculum	College Freshman Science Experience Curriculum Development	Practice-Oriented Masters Degree Program	Defense Graduate Internship Program	Defense S&E Reserve Corps Program
Engineering Our Digital Future Curriculum	Undergraduate Research Program	Encourage Establishment of Graduate Systems Engineering Degree Pgms	Graduate Research Traineeship Program	Service Graduate School (NPG and AFIT) Degree Expansion
Materials World Modules Curriculum		Regular (biennial) Critical S&E Skills Supply vs Demand Assessment (ID Educational Shortfalls)	National Defense S&E Graduate Fellowships Program	Systems Engineering Education with Industry (Experience Development)
Teacher Summer Fellowships Program			Systems Engineering Graduate Fellowships at Product Centers	
Teacher Summer Recurring Education Program				
Government Outreach Programs (Ex: Boy/Girl Scouts)				

Legend:	
	DDR&E Initiative
	NDIA Initiative

Other Initiatives

- Project Lead The Way
  - http://www.pltw.org/index.html
  - PLTW works with schools to implement an instructional program to prepare students to be successful in post secondary engineering and engineering technology programs

- Interagency Aerospace Workforce Revitalization Task Force
- Stem Investment Programs across government and Industry



National Security Science and Technology Workforce Division

- Provide a forum for effective interaction between government, industry, academia and the public at large for the strengthening of the national security Science, Technology Engineering and Mathematics (STEM) workforce,
- Overall objectives
  - Increasing NDIA's participation in exciting and attracting K-12 students into STEM careers
  - Maximizing cooperation between federal departments, agencies and industry on STEM workforce development initiatives
  - Supporting the development of integrated polices around the STEM workforce
  - Establishing partnerships to collect and disseminate information and coordinate resources to build a robust STEM workforce of the future.

Focus Areas for the NSSTWD

- **Focus Area / Objective 1**: Gather industry support for activities and initiatives that excite and attract young people (K-12) in pursuing STEM careers in the national security industry.
- **Focus Area / Objective 2**: Provide industry wide support to government STEM initiatives, such as the Interagency Aerospace Workforce Revitalization Task Force, the DSB Study on Nuclear Deterrence Skills Task Force and the Department of Energy led National Security Community Workforce "Stoplight" project.
- **Focus Area / Objective 3**: Produce a Defense Industrial Base Workforce Workshop by the end of calendar year 2007
- **Focus Area / Objective 4**: Engage and support the US Congress STEM caucus in evaluating and supporting legislation to improve STEM education and workforce development

Conclusions

- The Perfect Storm is upon us
  - Low supply of clearable, highly skilled workers, engineers and scientists is real
  - Retirements resulting in loss of institutional memory and effective mentors
- Solutions require a broad range of action
  - K-12
  - Vocational and Technical colleges
  - Higher Education
  - Government
  - Industry
- Full spectrum response required
  - Excite
  - Attract
  - Recruit
  - Train
  - Retain
- You can engage and make a difference!

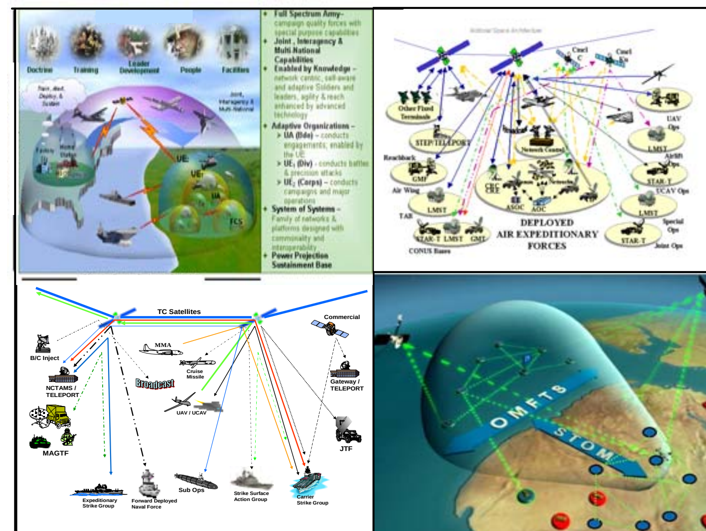
MILSATCOM Briefing National Defense Industrial Association (NDIA)

17 April 2007

Brig Gen Ellen Pawlikowski, Commander
MILSATCOM Systems Wing

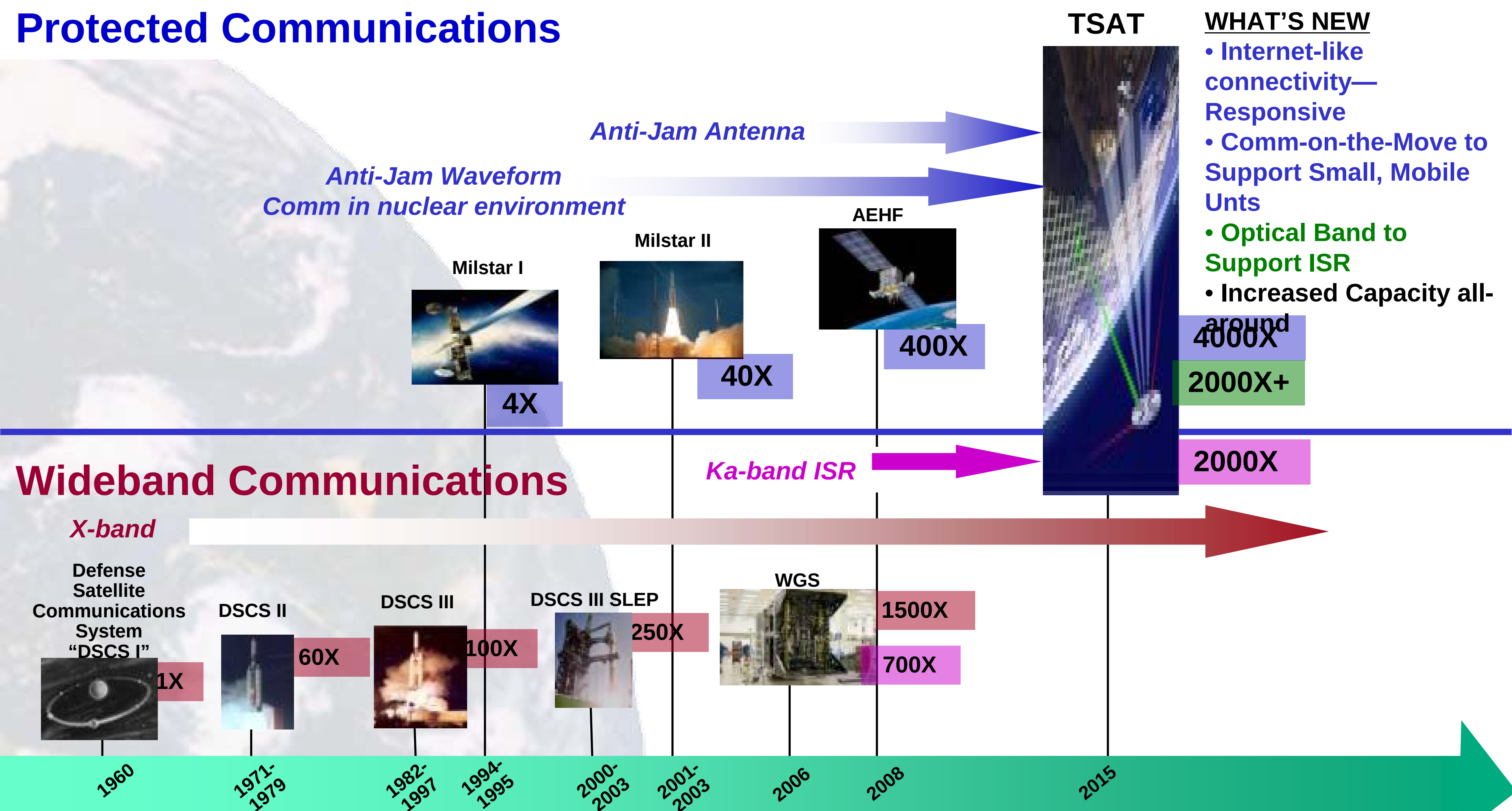
Transformational Satellite Communications System (TSAT) Description

- **Transforms satellite communications (SATCOM)**
  - **Extends DoD ground-based Global Information Grid (GIG) network to deployed and mobile users**
    - **Implements worldwide networking based on Internet Protocol**
    - **Laser communications (huge capacity gains)**
- **Enables service warfighting visions:**
  - **Mobile battle command on the move**
    - **Current systems force comm-on-the-pause, or -stop**
  - **Shared situational awareness**
    - **Red/blue force tracking; real-time intel**
    - **Complete sensor-to-shooter (through C2) capability**
  - **Collaborative, offensive-oriented planning**
    - **Enables dynamic/high-tempo operations**
  - **Provides assured command & control to strategic forces**
  - **Linchpin for 21st century net-centric warfare**
    - **Communicate as a joint networked force**



Military Satellite Communications

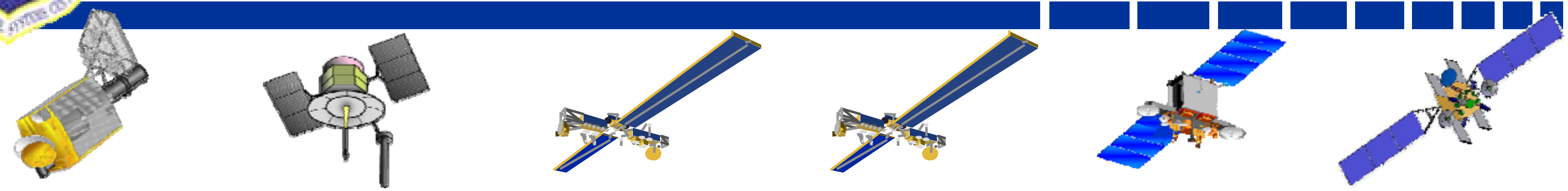
1960 - 2015



Continuous Capacity and Protection Improvements: Being Responsive to our Warfighter Needs

Evolution of Onboard Signal Processing for Protection and Connectivity

Highly Robust → Wide Bandwidth → Efficient



Mid ’70s | **Mid-Late ’80s** | **Early ’90s** | **Late ’90s** | **2005** | **2015**

LES 8/9

First space-based spread spectrum and communication processing

Single channel

FEP

First EHF (44/20 GHz)

Multiple channel processing

First onboard circuit-based DAMA

Validated architecture

Milstar I

First strategic / tactical operational EHF spacecraft

LDR only

Electronically agile beams

Milstar II

10x capacity increase (MDR)

Nulling antenna

AEHF

10x increase in capacity (XDR)

Increased accesses for small terminals

First protected bandwidth-efficient waveform (binary only)

Remains circuit-based DAMA

TSAT

10x increase in RF capacity (XDR+)

Increased bandwidth efficiency (up to 16-ary)

IP routing

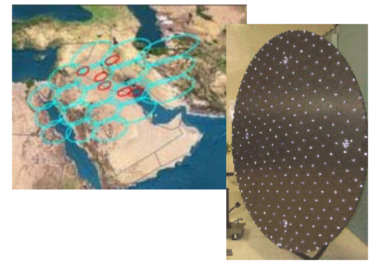
Dynamic packet-based resource allocation

High-gain theater coverage (COTM)

3 orders of magnitude capacity increase

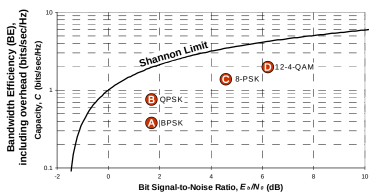
TSAT Critical Technologies

- **Battle Command On the Move (BCOTM)**

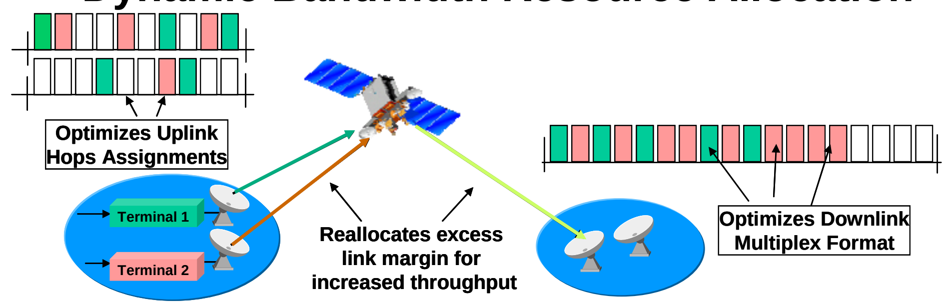


- **Next Generation Processor/Router**

  - **Bandwidth Efficient Modulation**



  - **Dynamic Bandwidth Resource Allocation**



- **Transec**

COVER

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

16 independent uplink cover keys per satellite

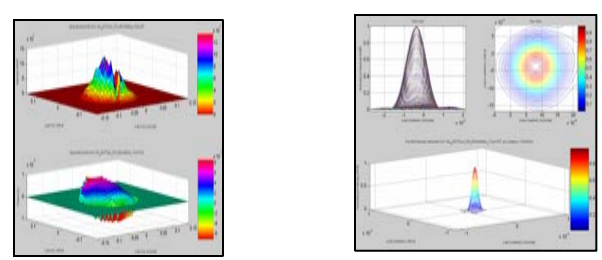
Frequency Hopping

STRAT	Tactical

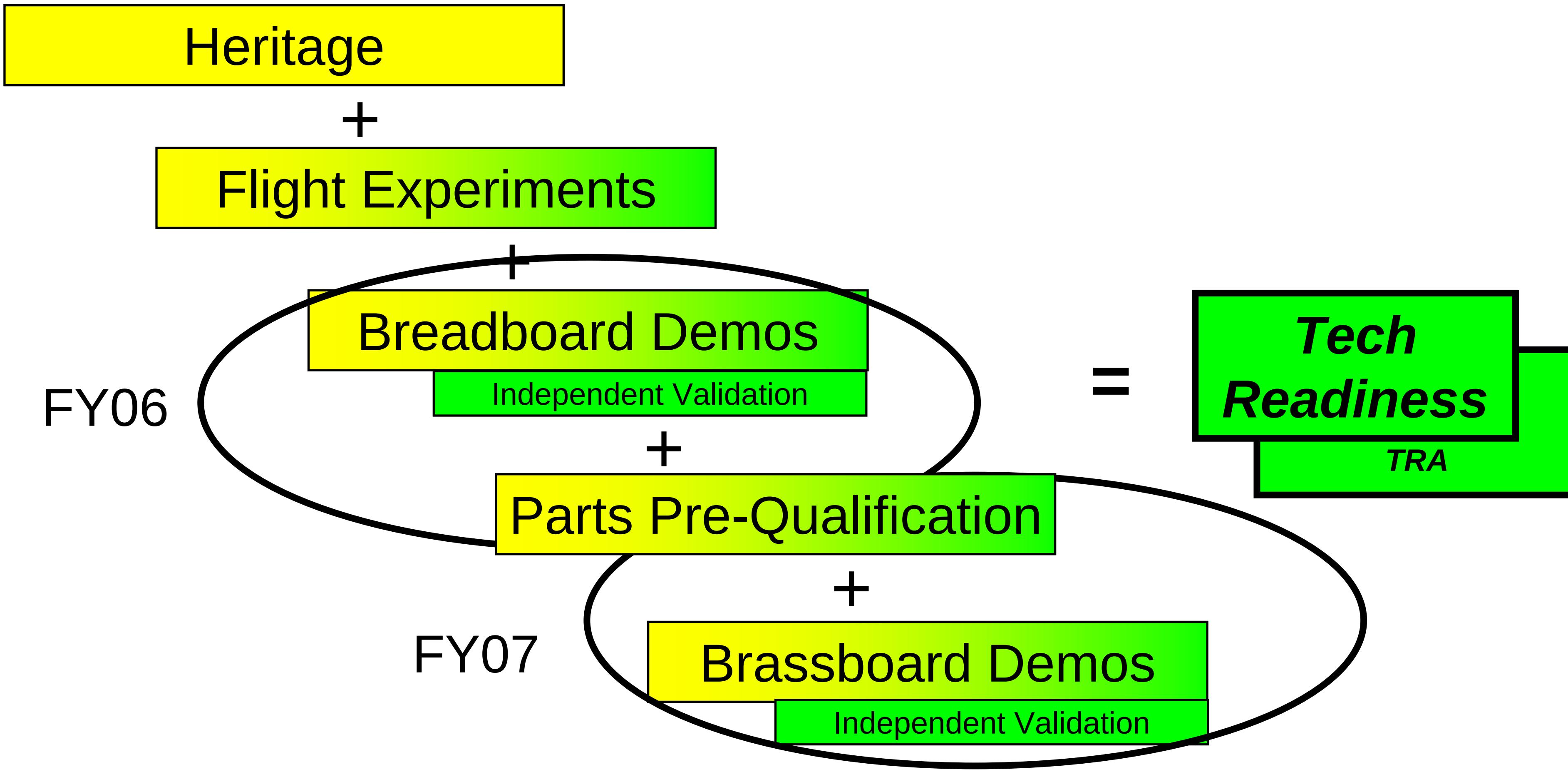
Two independent uplink patterns per satellite

- **Space HAIPE**

- **Lasercom**

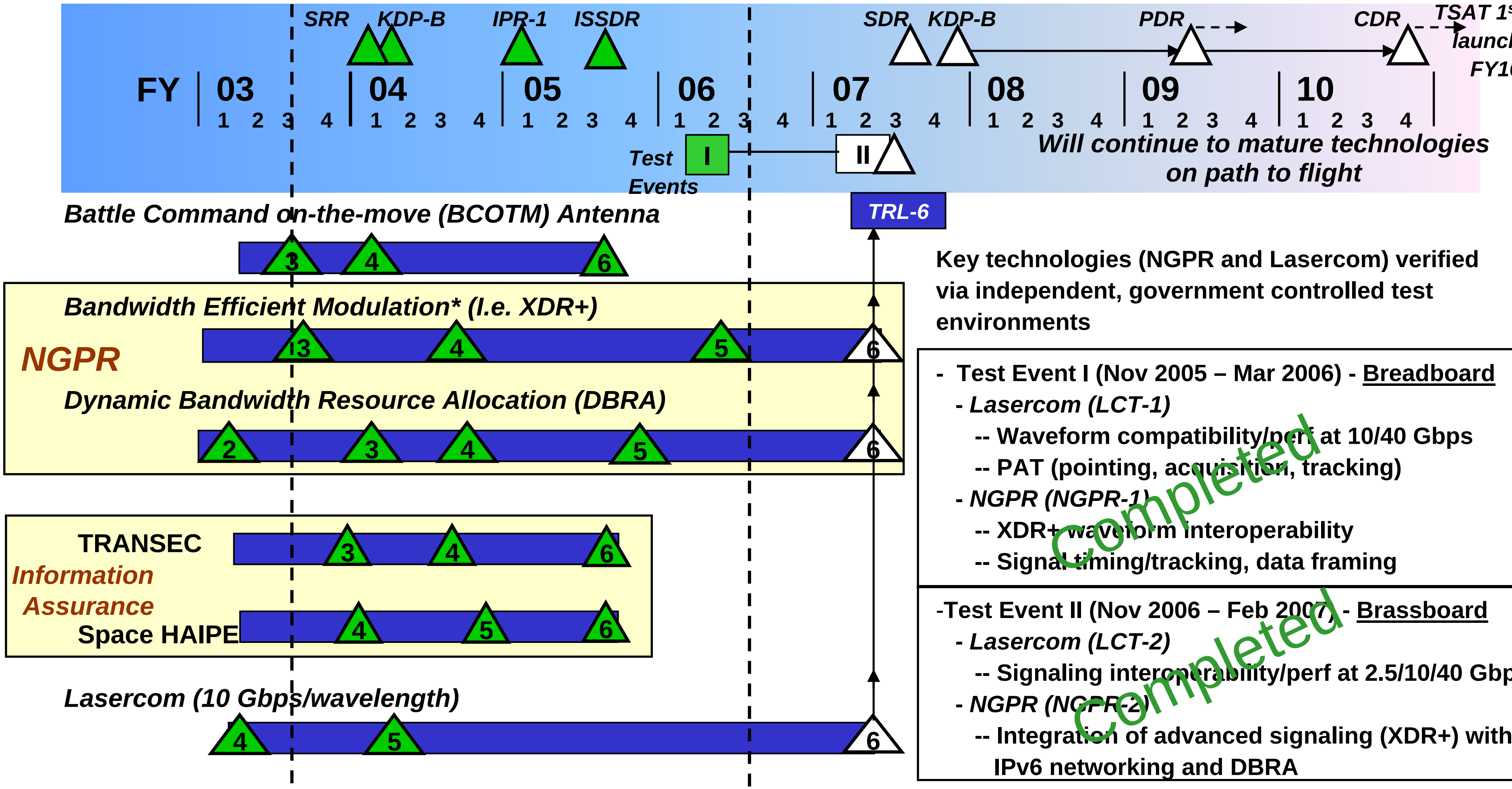


TSAT Definition of Technology Maturity/Readiness



Multiple activities used to establish tech readiness

TSAT Technology Readiness Level (TRL)



Key technologies (NGPR and Lasercom) verified via independent, government controlled test environments

- Test Event I (Nov 2005 – Mar 2006) - <u>Breadboard</u>
  - *Lasercom (LCT-1)*
    - -- Waveform compatibility/perf at 10/40 Gbps
    - -- PAT (pointing, acquisition, tracking)
  - *NGPR (NGPR-1)*
    - -- XDR+ waveform interoperability
    - -- Signal timing/tracking, data framing

Completed

-Test Event II (Nov 2006 – Feb 2007) - <u>Brassboard</u>
  - *Lasercom (LCT-2)*
    - -- Signaling interoperability/perf at 2.5/10/40 Gbps
  - *NGPR (NGPR-2)*
    - -- Integration of advanced signaling (XDR+) with IPv6 networking and DBRA

Completed

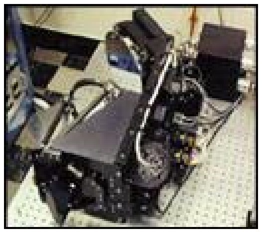
Key technologies will be demonstrated to TRL-6 by KDP-B

HAIPE: High Assurance Internet Protocol Encryption

ISSDR: Interim Space Segment Design Review
OSVS: Optical Standards Validation Suite
NGPR: Next Generation Processor Router

Maturation Example: Lasercom

Heritage



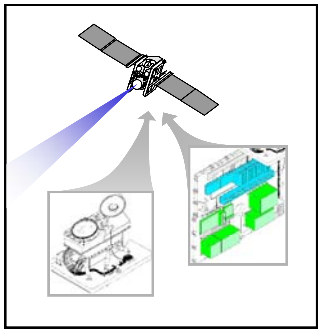
LITE-2 EM
(Fiber-Based)
1990's

Introduction of commercial parts

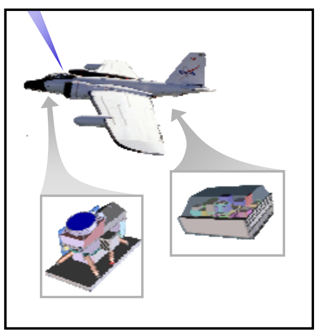
- Leverage large-scale manufacturing processes

Pre 2000

Flight Experiments



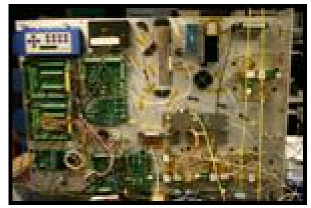
Lasercom Experiment
(GeoLITE, 2001)



Airborne Laser Experiment
Alex Demonstration (2002)

2001/2

Breadboard



2005

Parts Prequal

Key components/subassemblies

- Optical fiber
- Optical & RF Filters
- Optical & RF Modulators/Demodulators
- Diode transmitters/receivers
- Optical switches
- Interferometers
- Couplers/isolators

Vendor development and major Environment Testing (examples)

- Failure modes and Effects Analysis (FMEA)
- Thermal temperature cycling
- Vacuum
- Vibration
- Mechanical Shock
- Total Dose
- Prompt Dose /SEU

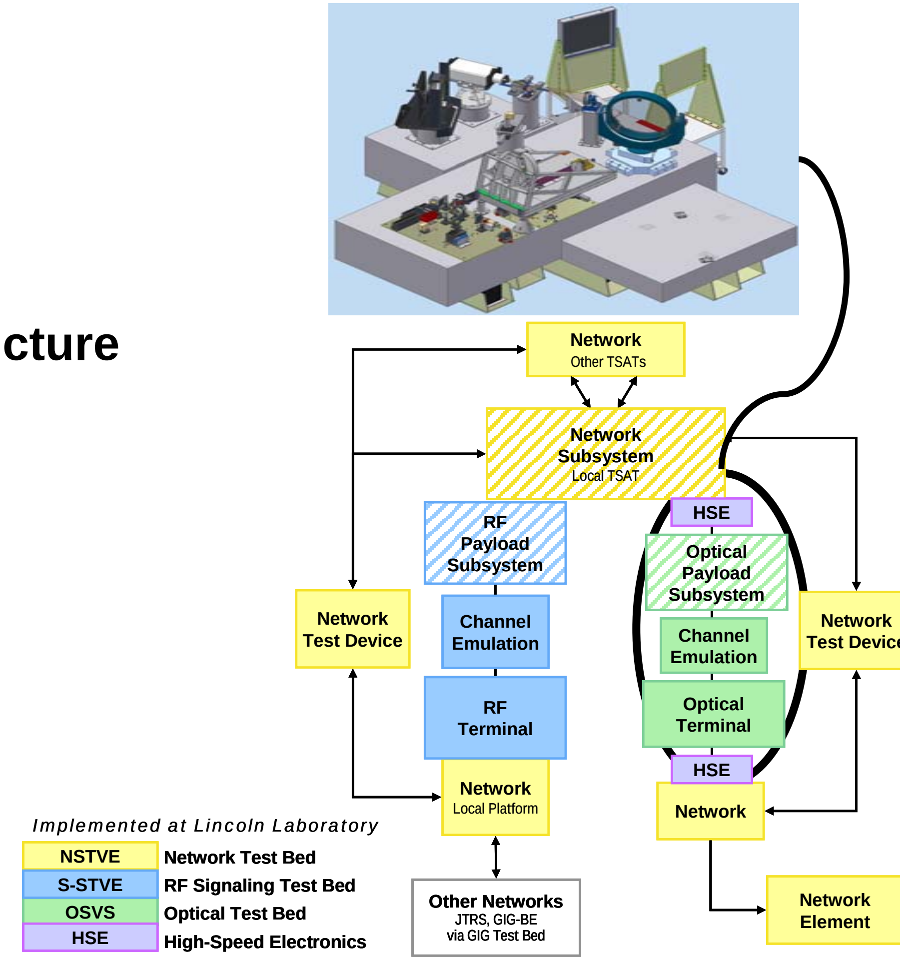
2006

Brassboard

2007

Independent Validation

- Independent test assets
  - Network, RF, Optical, and High-Speed Electronics Test Systems
  - Operate stand-alone or as part of integrated infrastructure
- Government test team
- Government assessment of functionality/performance

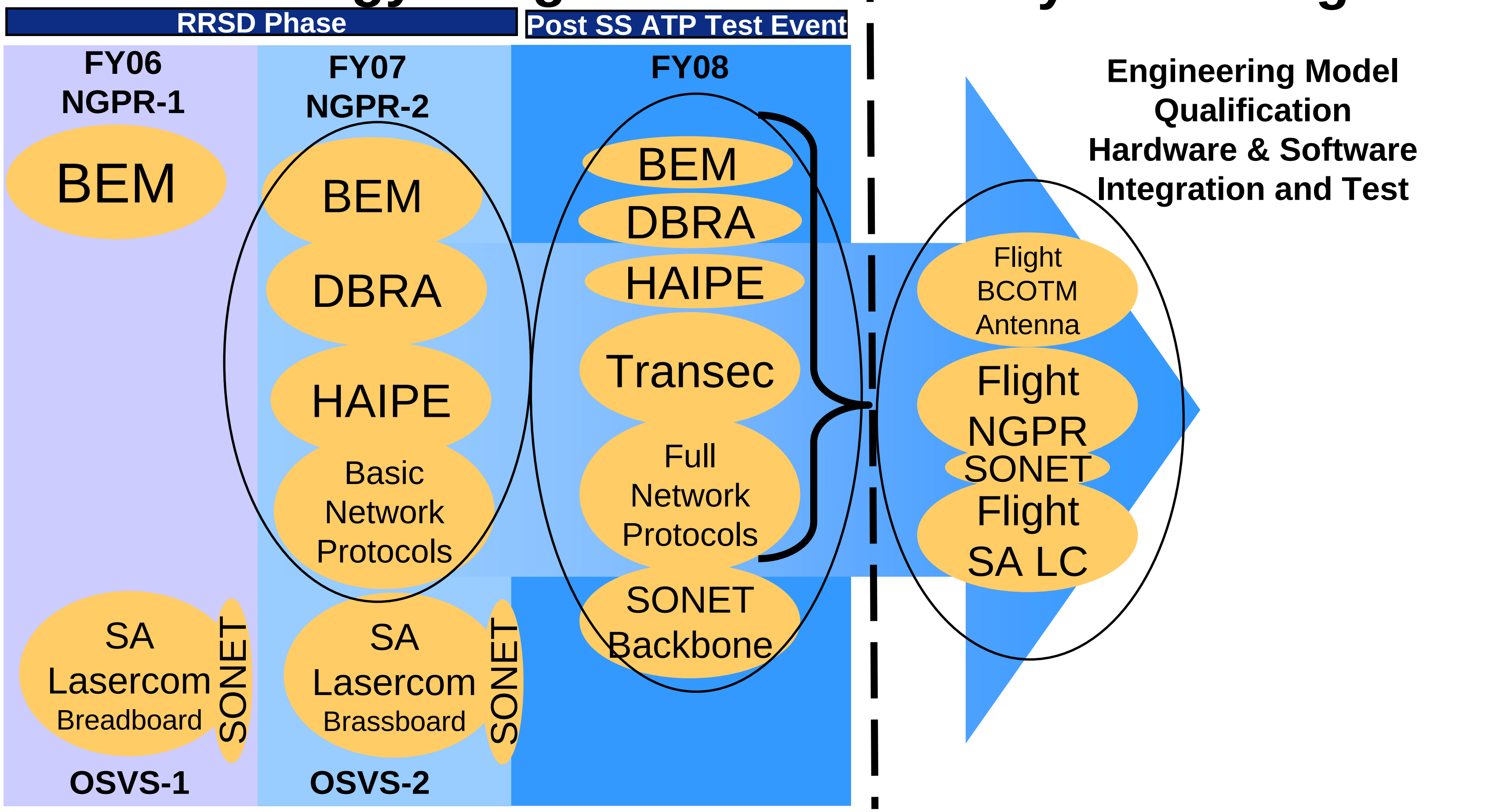


Independent test capability for Government technology performance assessment

Next Steps in Technology Maturation

Technology Integration

System Integration



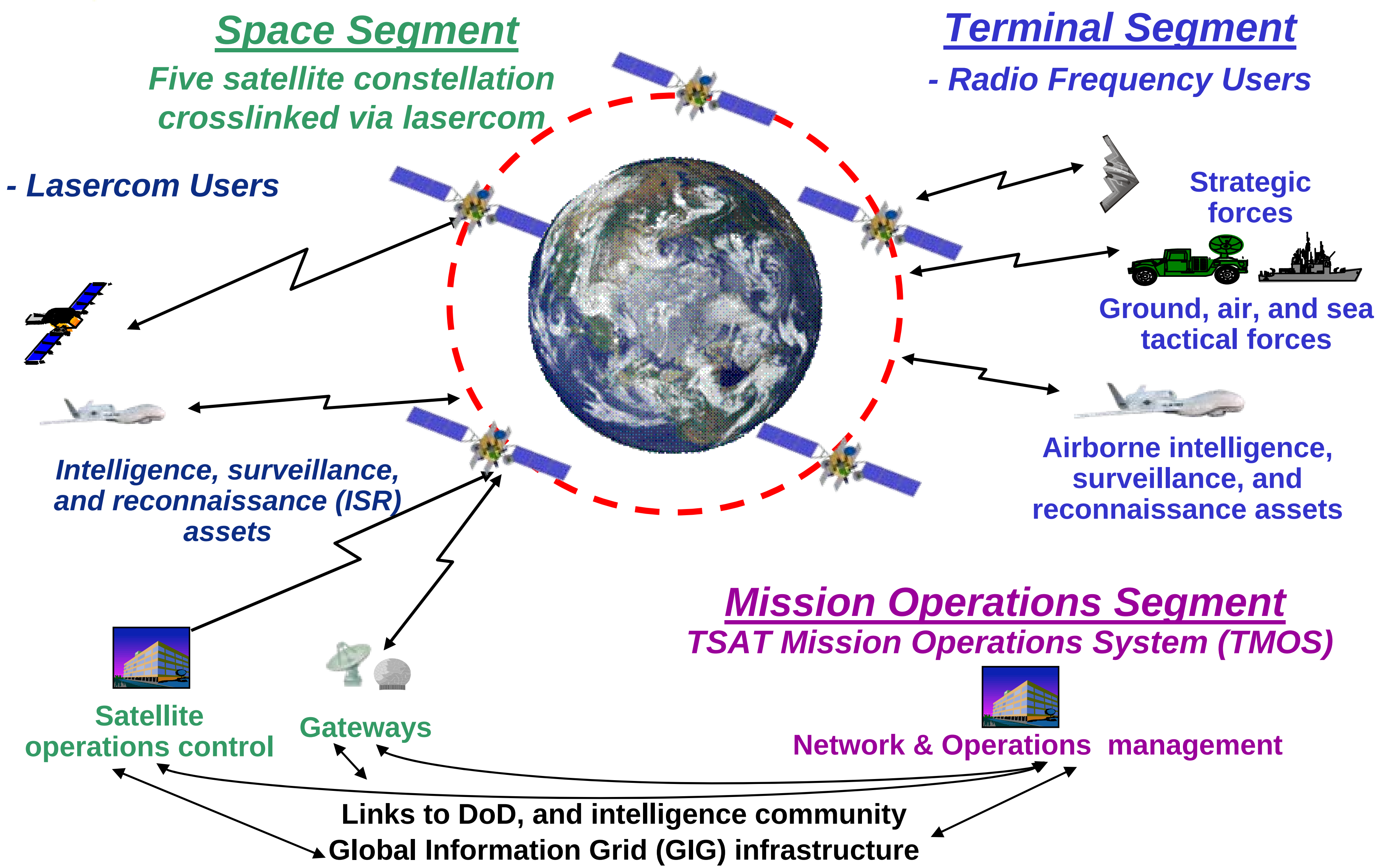
Higher risk integration prior to SS ATP, lower risk afterward

Back Up

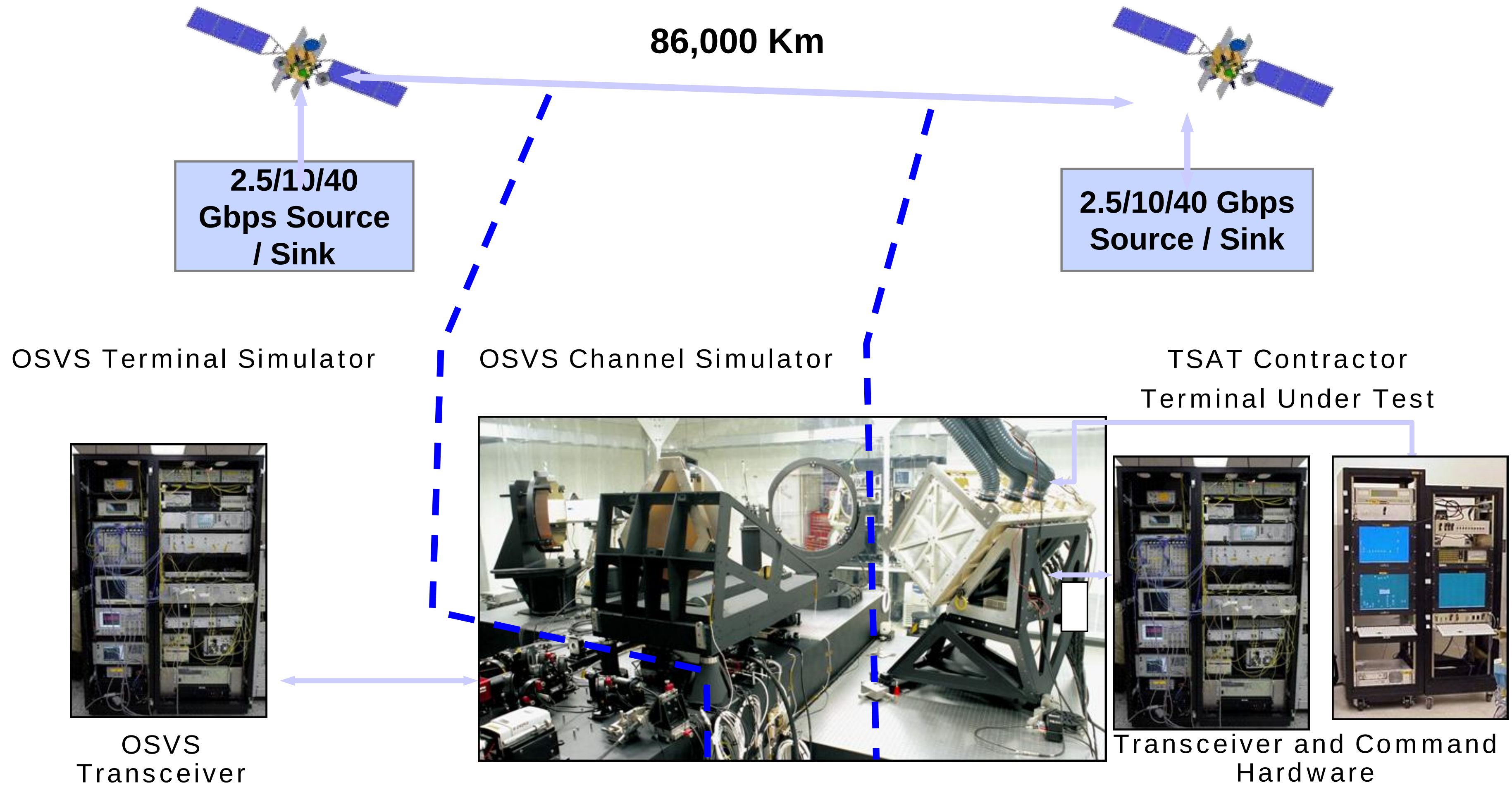
Summary

- **MILSATCOM history**
  - **Continual expansion by leveraging the latest technology**
- **Space systems development**
  - **Need to balance technology risk versus performance**
  - **Disciplined technology maturation is essential**
- **Transformational communications success hinges on successful technology maturation**
  - **Technology demonstration on track to TRL-6**
  - **More maturity and integration planned for the future**

TSAT System


Space Segment
Five satellite constellation
crosslinked via lasercom
- Lasercom Users
Intelligence, surveillance,
and reconnaissance (ISR)
assets
Terminal Segment
- Radio Frequency Users
Strategic
forces
Ground, air, and sea
tactical forces
Airborne intelligence,
surveillance, and
reconnaissance assets
Mission Operations Segment
TSAT Mission Operations System (TMOS)
Satellite
operations control
Gateways
Network & Operations management
Links to DoD, and intelligence community
Global Information Grid (GIG) infrastructure

LCT-2 Free Space Communications Testing Complete: Feb 07

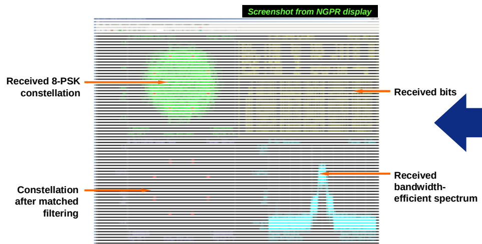


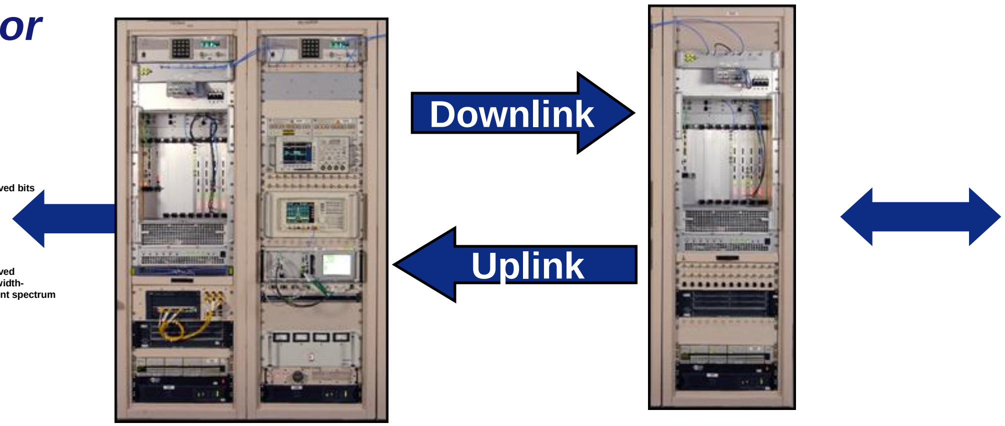
Independent testing of LM-NGST and BSS terminals accomplished on schedule

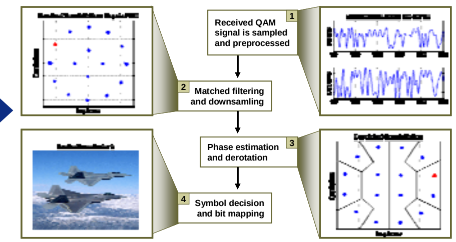
NGPR-2 Bandwidth Efficient Modulation (BEM) Testing Complete: Feb 07

NGPR Payload/Terminal Simulator

Contractor NGPR under test







Uplink Received Signal Processing

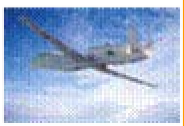
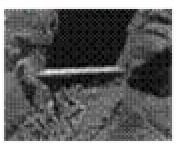
Downlink Received Signal Processing

Uplink rates 2.4 Kbps – 118 Mbps
Downlink rates up to 311 Mbps

- **Four new TSAT modulation / coding pairs for XDR+ provide more throughput in fixed bandwidth**
  - **Enable power efficiency and interference protection**
  - **Allow multiple users to share a single band**

Testing Network communications with TSAT XDR+ uplink/downlink waveform

WGS vs. AEHF vs. TSAT

		WGS Per Satellite	AEHF Per Satellite	TSAT Per Satellite
	<u>BCOTM</u>* 1’ Antenna	--	COTP--140 links @ 32 Kbps⬆ 256 Kbps⬇	300 links*** @ 1544 Kbps
	AISR High Resolution	2 links @ 274 Mbps	--	6 links @ 311 Mbps
	AISR Hyperspectral	--	--	6 links@2448 Mbps**
	Space Based ISR	--	--	Up to 10 Gbps
	Connectivity	Pt to Pt to multipoint	Pt to Pt to multipoint	Full mesh—anyone to everyone
	Strategic	--	Yes	Yes

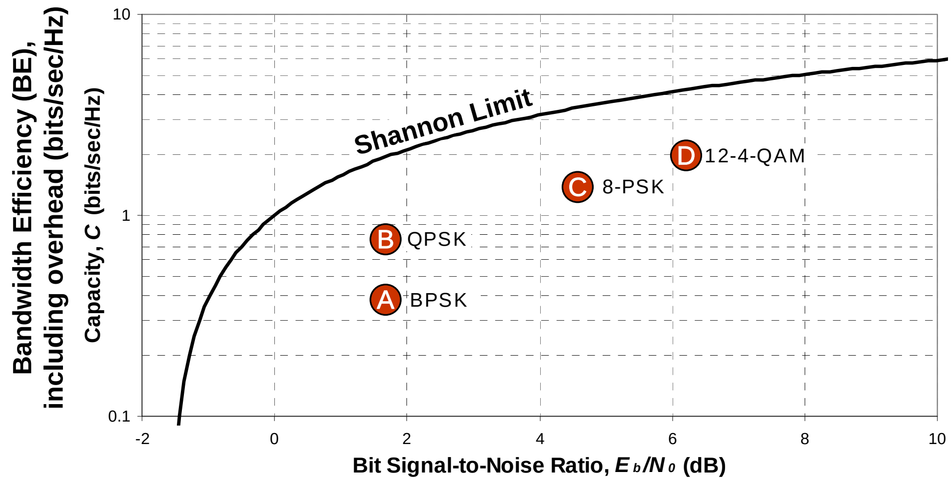
* Battle Command on-the-Move (BCOTM) includes network core services, such as Voice, VTC, Broadcast Imagery, Web-based Traffic

* Overall constellation available laser links

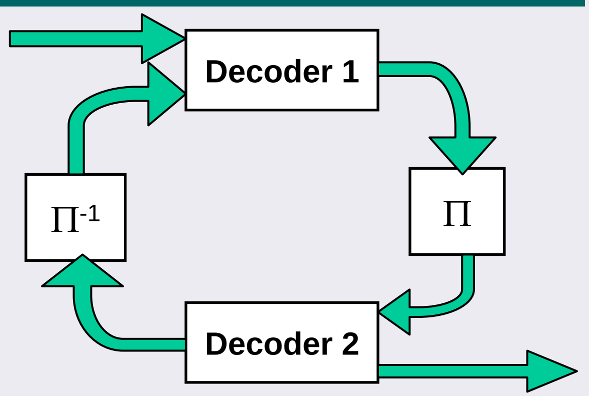
*** TSAT router enables BCOTM urban operations

Protected Bandwidth Efficient Modulation (PBEM)

- **Four new TSAT (XDR+) modulation / coding pairs provide more throughput in fixed bandwidth**

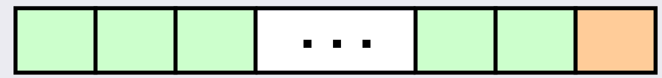


Iterative Decoding and Interleaving



Enable power efficiency and interference protection

Timing and Hop Framing



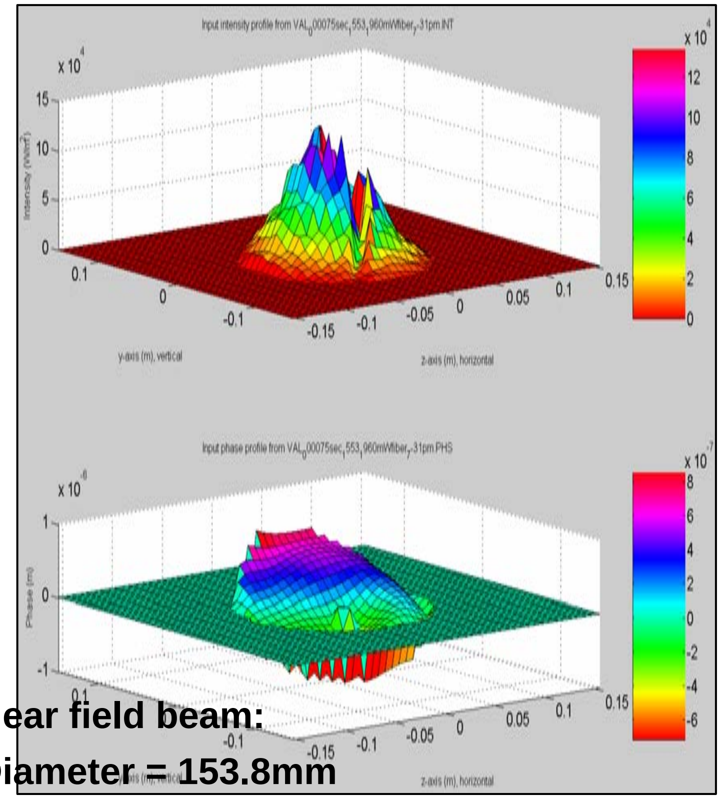
Allow multiple users to share a single band

Comm accesses

Time probe accesses

OSVS Test Result Example
Data Shown Taken on LL Terminal

WFS Data Yielding
Radiant Intensity



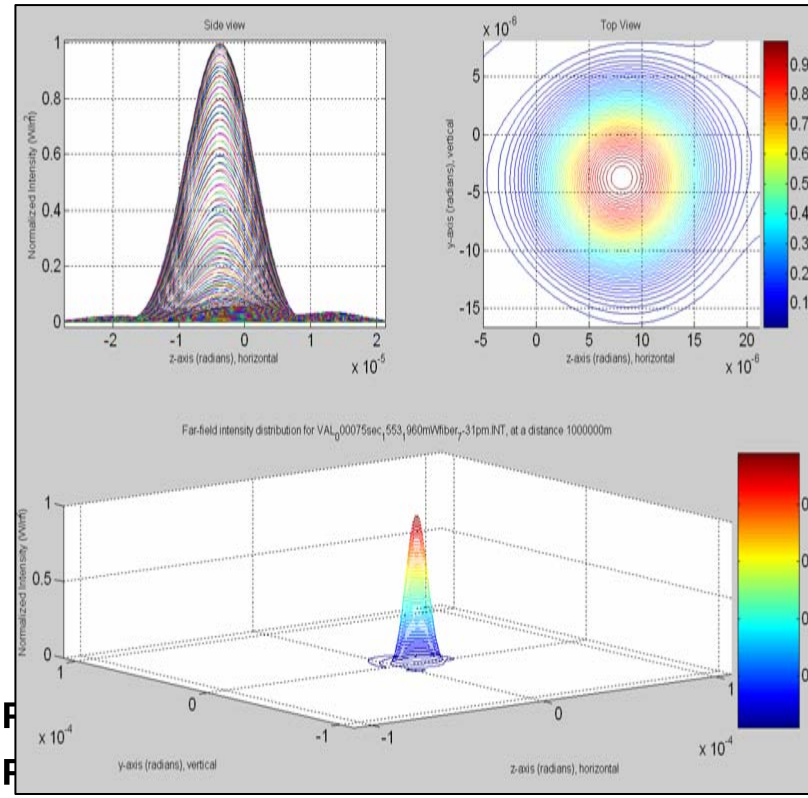
Near field beam:

Diameter = 153.8mm

Rms wfe (tilt removed) = 0.053λ rms

Note: 12-inch relay used

Narrow Beam of Source

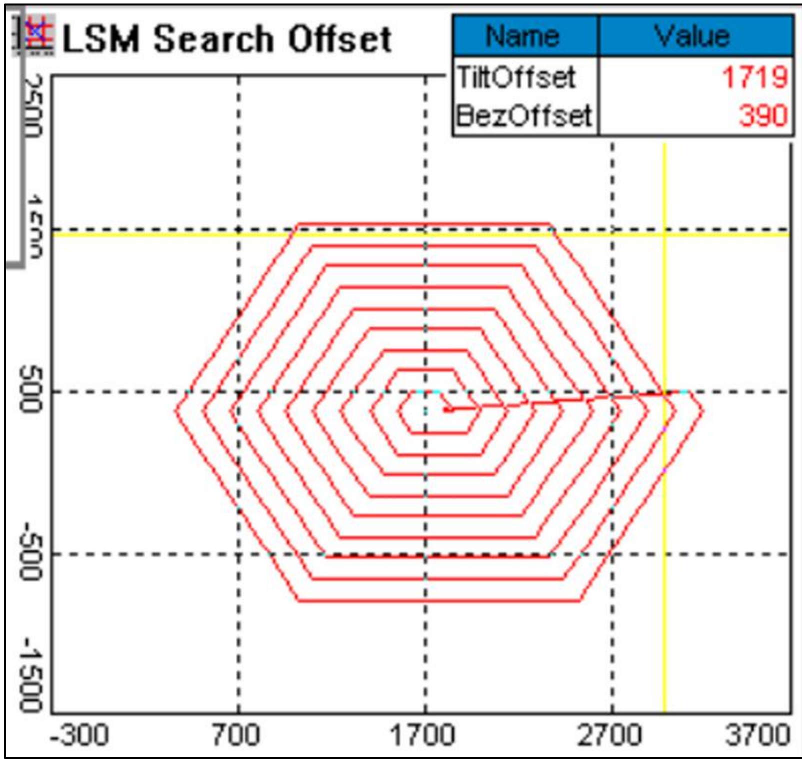


1/e2 radius = 9.30μrad

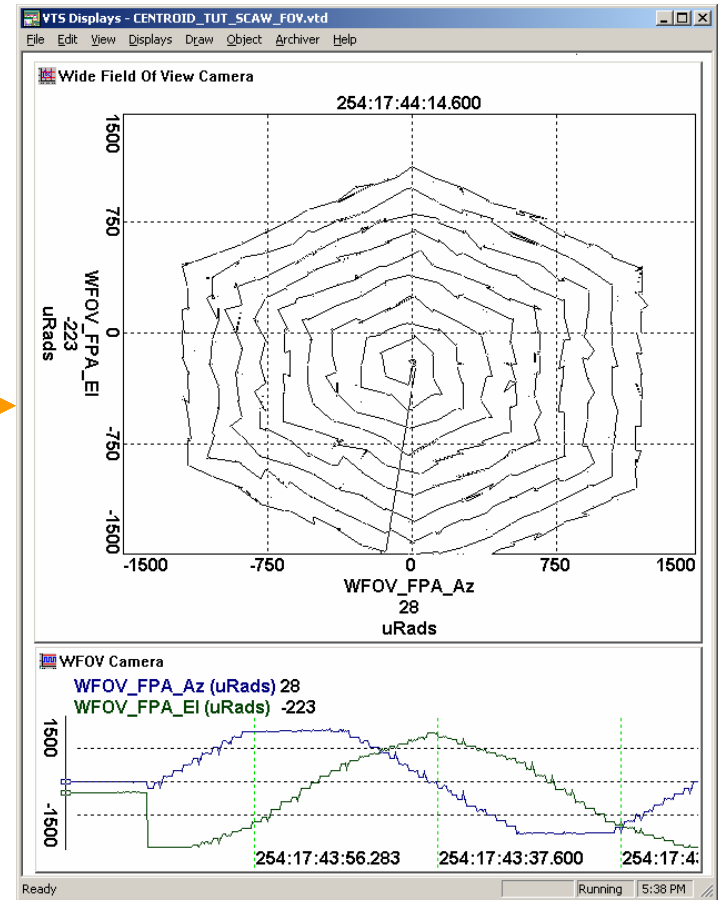
PAT Telemetry Displays Used in TUT Testing

Example Data Shown Taken on LL Terminal

TUT Mirror Commanded



OSVS Observed



Ability to measure μrad scans demonstrated

TSAT Space and Terminal Synchronization

	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25
TSAT					★	★		★	★	★				
Legacy AEHF Terminals	562	666	762	731	742	742	737	683	658	606	563	533	529	529
TSAT Terminals (XDR+ and/or Ka Proc.)			129	448	756	1152	1375	1678	2129	2964	3733	4385	4728	5017
Lasercom														

Data Call: ***POM08***
Current as of: ***3/7/2007***

★ = Launch

Space Segment: Pre-IOC | IOC | FOC

Total # of Terminals Fielded in

Terminal Segment: # 0% - 19% | # 20% - 84% | # 85% - 100%

- **Terminal fielding based on Services POM08 plans (Fall 2006)**
- **Terminal fielding numbers represent the cumulative number of terminals from all Services**
- **At TSAT IOC in FY17, 742 AEHF terminals and 1152 TSAT terminals fielded**
  - **Issues: HC3 COTM not synchronized with TSAT, no plans for Airborne Lasercom Terminal**

NDIA Science and Engineering Technology Conference/ DoD Technology Exposition

April 19, 2007

Gary Powell
OUSD(AT&L)
gary.powell@osd.mil

Outline

- Industrial Policy
- Emerging Defense Industrial Environment
- Challenge

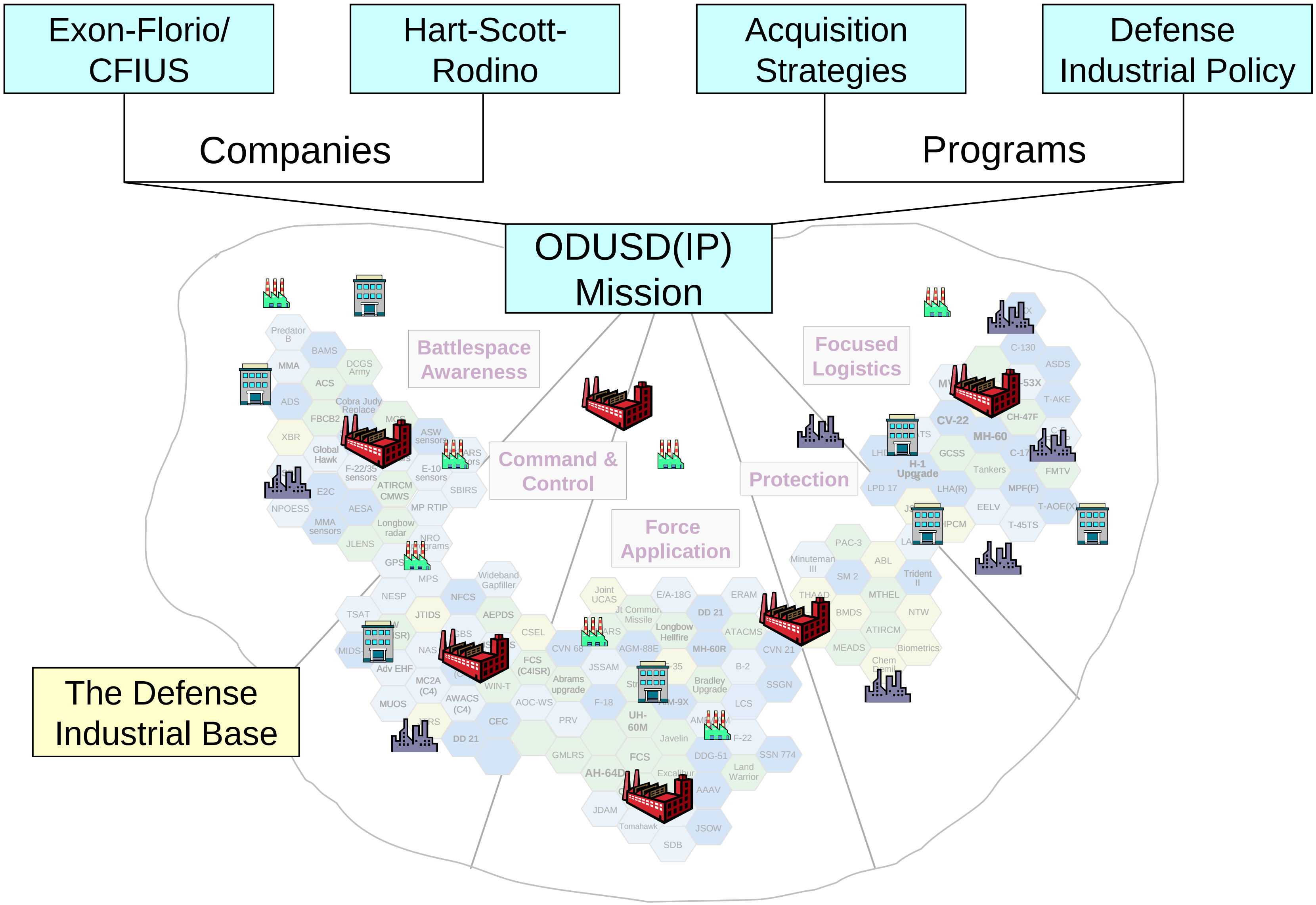
AT&L Goals

1. High Performing, Agile and Ethical Workforce
2. Strategic and Tactical Acquisition Excellence
3. Focused Technology to Meet Warfighting Needs
4. Cost-Effective Joint Logistics Support for the Warfighter
5. Reliable and Cost-Effective Industrial Capabilities Sufficient to Meet Strategic Objectives
6. Improved Governance and Decision Processes
7. Capable, Efficient, and Cost-Effective Installations

Assessing Desired Attributes

Metric	Measure/Source
DoD Funding Level/Stability	Current/Projected DoD budgets
Delivery Performance	EVM data (e.g., schedule performance index)
Cost Performance	EVM data (e.g., cost performance index)
Technical Performance	Progress in meeting key performance parameters
Company Viability	Business base, return on investment, cash flow, market valuation, earnings-per-employee, IR&D, capital expenditures
Workforce	Employment/workforce data (to include hiring, retention, special skills, etc.)
Competitiveness	# of suppliers, non-defense (dual-use) sales, export sales, etc.
Problem Areas	Sick suppliers, capability gaps, capacity shortfalls (peacetime, surge)

Major Levers of Industrial Policy



DoD Merger and Acquisition Reviews

- AT&L and General Counsel conduct DoD evaluation and facilitate regulator's review*
  - Interview parties, competitors, customers, and Department representatives
  - Develop judgments on:
    - Impact on current and future markets & programs
    - Effects on industrial capabilities and technology
    - Effects on DoD of business or technical risks
    - Competitive effects (vertical and horizontal)
    - Organizational conflicts of interest
    - Benefits and efficiencies
- Neutral policy to allow mergers to achieve benefits of consolidation and block or modify mergers to maintain benefits of competition (case-by-case basis)
- ~300 transactions reviewed since March 1994 -- $600B
  - ~40 required some form of remedy
  - 8 transactions were not consummated due to antitrust agency and DoD concerns

- DoJ and FTC responsible for antitrust review of mergers
  - Hart-Scott-Rodino threshold of >$58M
  - Regulators also review Joint Ventures
- DoD works with DoJ and FTC
- DoD selectively reviews transactions involving major defense suppliers with significant Defense investments that may have impact
  - Generally >$58M, but may be smaller

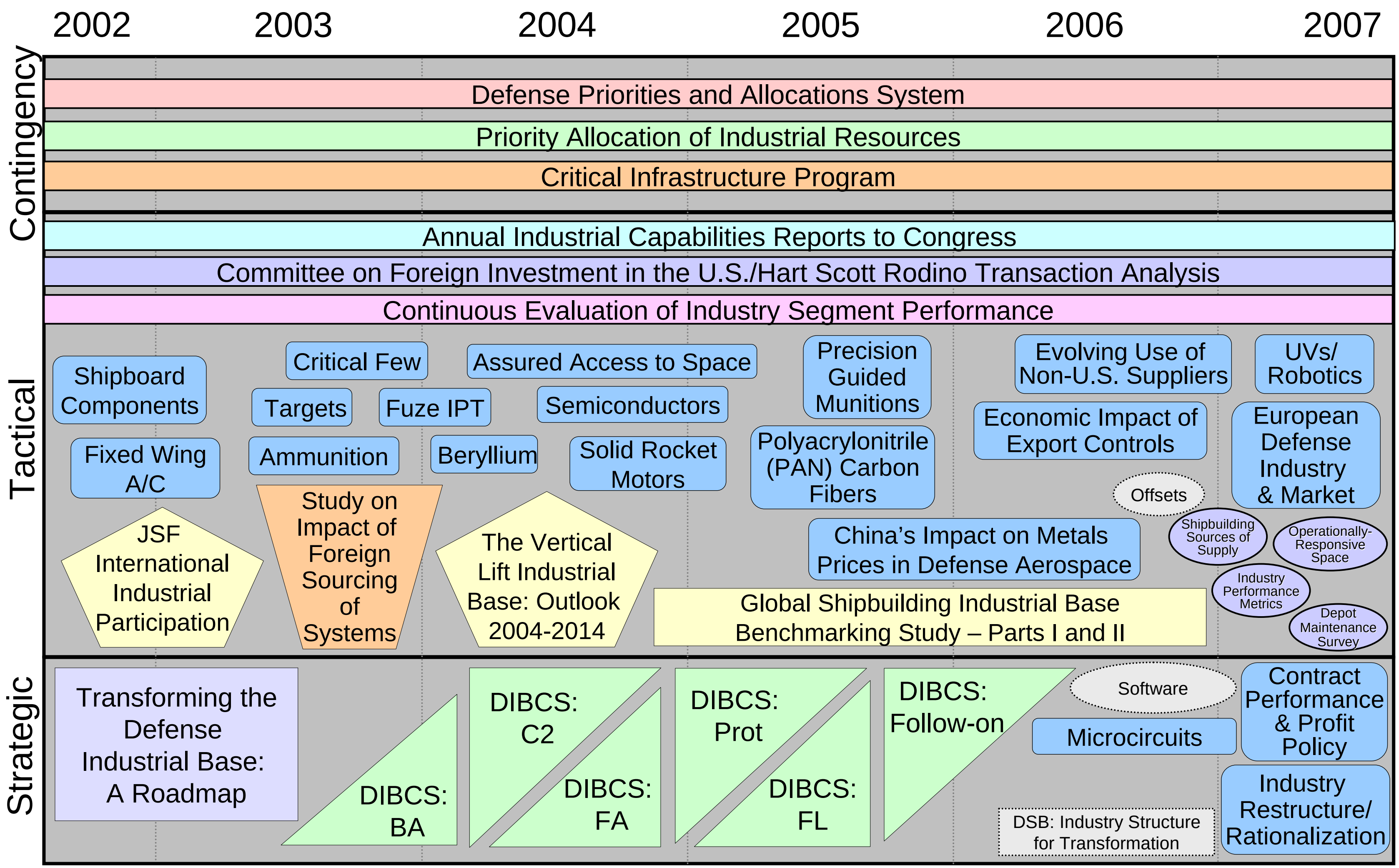
*DoD Directive 5000.62 of October 1996

DoD CFIUS Reviews

- Sensitivity of U.S. firm being acquired
  - Presence of critical defense technology
  - Important to the defense industrial base
  - Classified contracts
- Foreign Firm acquiring
  - Intelligence assessment of company & country
    - Compliance with export licensing regulations & international agreements
    - Sales activity with potential U.S. adversaries
    - Targeting of critical technology
    - Reliability as a supplier to DoD
  - Existence of foreign government ownership
- Remedies
  - Corporate governance controls
    - Outside directors, Technology Control Plans
  - MOUs with the parties
  - Divestitures
  - Presidential Investigation
    - Potential block of the transaction

- CFIUS Organizational Roles
  - Treasury Dept chairs
  - USD(Policy) – DoD lead
  - USD(AT&L) – technology & industrial base analysis
- CFIUS Notification Thresholds
  - Notification voluntary but CFIUS can initiate a review
  - No transaction value guidelines for filing
- Statutory timing
  - Initial 30 day review conducted by CFIUS
  - Additional 45-day Investigation if national security threats exist and are unresolved
  - Presidential decision and report to Congress 15 days after Investigation

DUSD(IP) Industrial Base Activities

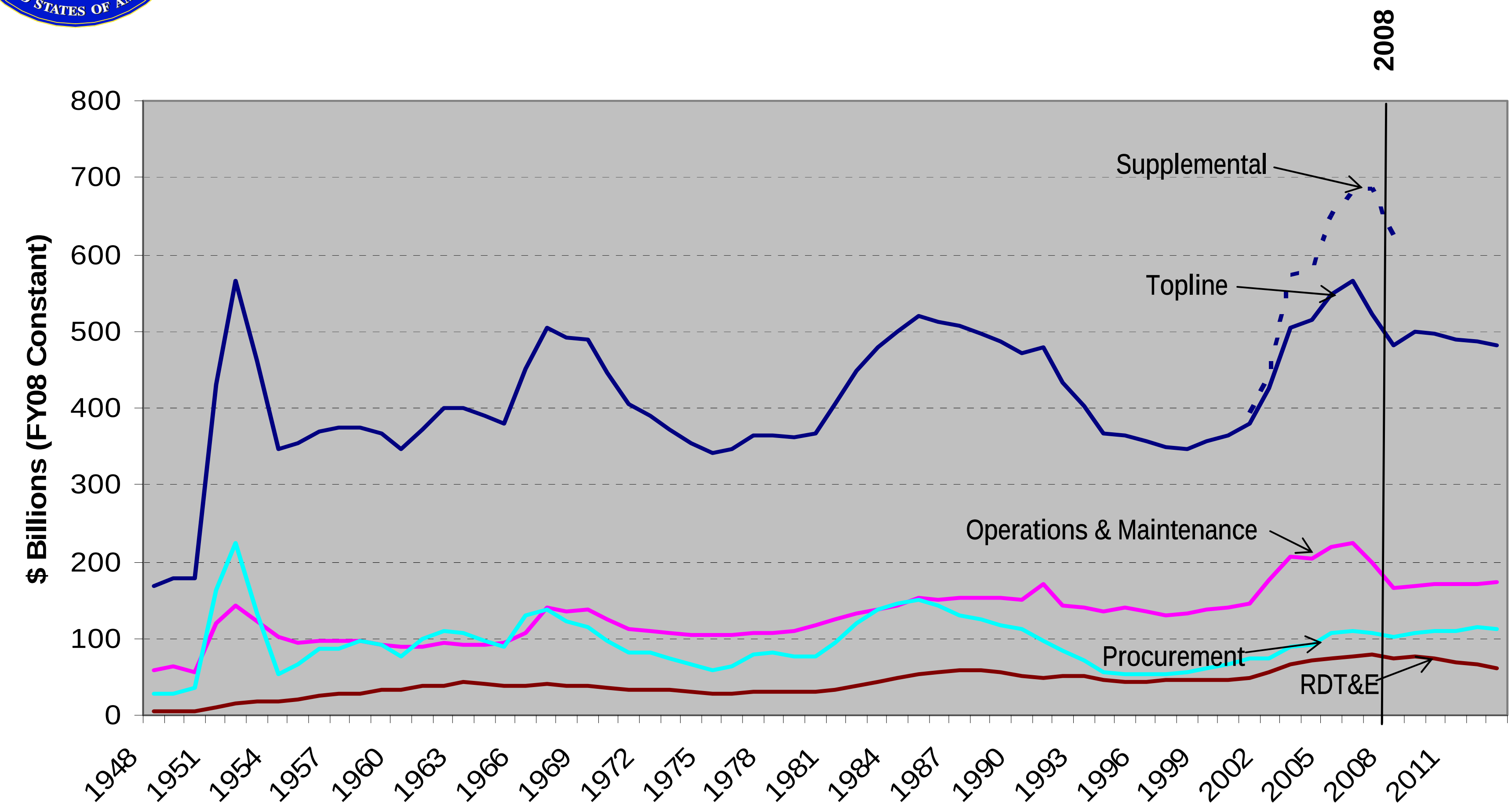


Outline

- Industrial Policy
- Emerging Defense Industrial Environment
- Challenge

Defense Budget Trends

(DoD Budget Authority)



Source: USD (Comptroller) National Defense Budget Estimates for the FY 2008 Budget (Green Book)

Foreign Sources of Supply – Annual Report to Congress

Summary of Awards to Foreign Entities						
	# of Competitive Contracts	Value of Competitive Contracts	# of Non-Competitive Contracts	Value of Non-Competitive Contracts	Total Number of Contracts	Total Value of Contracts
FY 2003	1,079	$ 450,663,875	1,218	$ 564,908,551	2,297	$ 1,015,572,426 **(~1.5% of total)**
FY 2004	917	$ 451,354,502	1,214	$ 1,046,077,739	2,131	$ 1,497,432,241 **(~2.0% of total)**
FY 2005	1,120	$ 445,145,252	1,347	$ 1,445,638,152	2,467	$ 1,890,783,404 **(~2.4% of total)**

U.K. and Canadian firms were prime beneficiaries: ~60% of the total

Note: Defense articles and components only

Sources: *Foreign Sources of Supply: Assessment of the United States Defense Industrial Base*, November 2004, March 2005, and April 2006

Defense Trade Balance

(U.S. Exports vs. Imports)

Source: GAO analysis of U.S. Census Bureau data

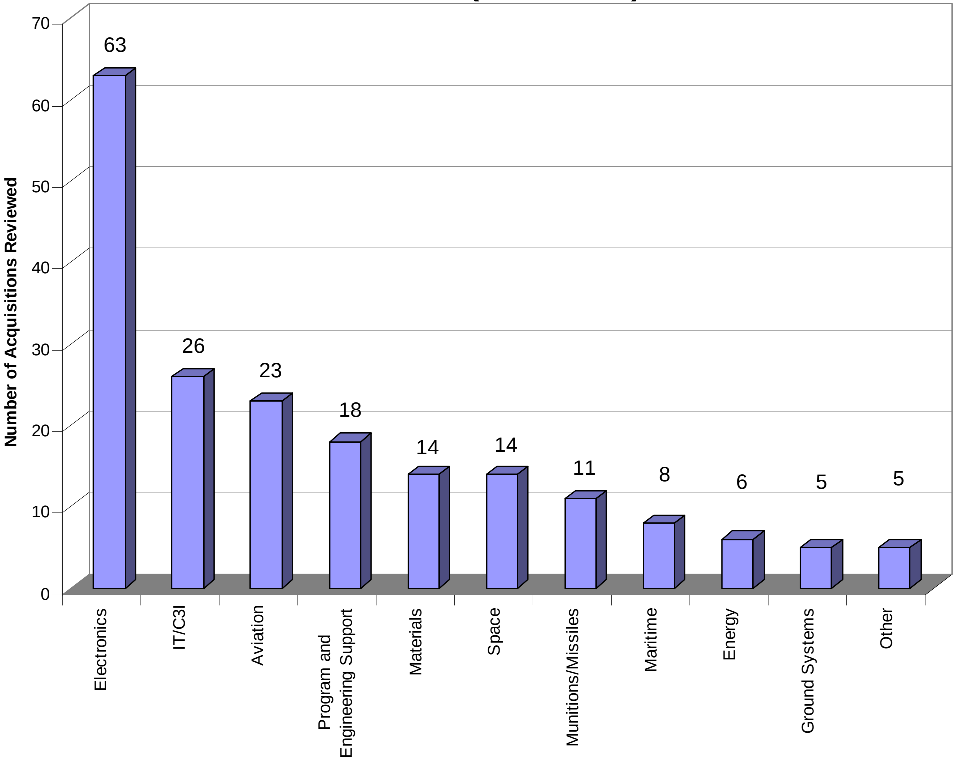
Foreign Sourcing Study – January 2004

Program	# Foreign Subcontractors	Value of Foreign Subcontracts ($M)	Value of Foreign Subcontracts as a % of Total Subcontracts	Value of Foreign Subcontracts as a % of Prime Contract Value
JSLIST	8	$35.0	62.5%	12.5%
PAC-3	25	$23.1	12.3%	6.2%
F414	4	$19.1	10.9%	4.6%
PREDATOR	5	$1.0	14.5%	3.3%
WCMD	11	$2.0	4.3%	3.2%
TACTICAL TOMAHAWK	3	$6.8	5.5%	2.8%
SFW	4	$2.9	7.8%	2.5%
GMLRS	3	$2.6	6.1%	2.3%
SLAM-ER	5	$1.0	3.3%	1.6%
ATACMS	3	$2.2	3.8%	1.5%
PAVEWAY	1	$0.7	0.4%	0.2%
JSOW	1	$0.1	0.1%	0.1%
Subtotal without JSLIST	**65**	**$61.5**	**6.6%**	**3.2%**
Total	**73**	**$96.5**	**9.8%**	**4.3%**

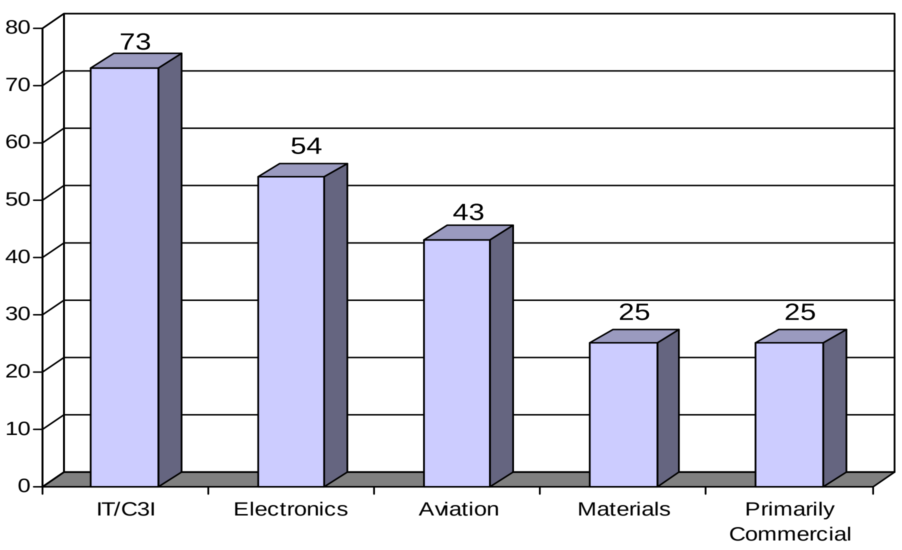
Source:*Study on Impact of Foreign Sourcing of Systems,* January 2004

DoD Merger Reviews: Acquisitions by Product Sector

HSR filed acquisitions by Product Sector (2000-2006)



CFIUS Filed Acquisitions by Product Sector (2001-2005)



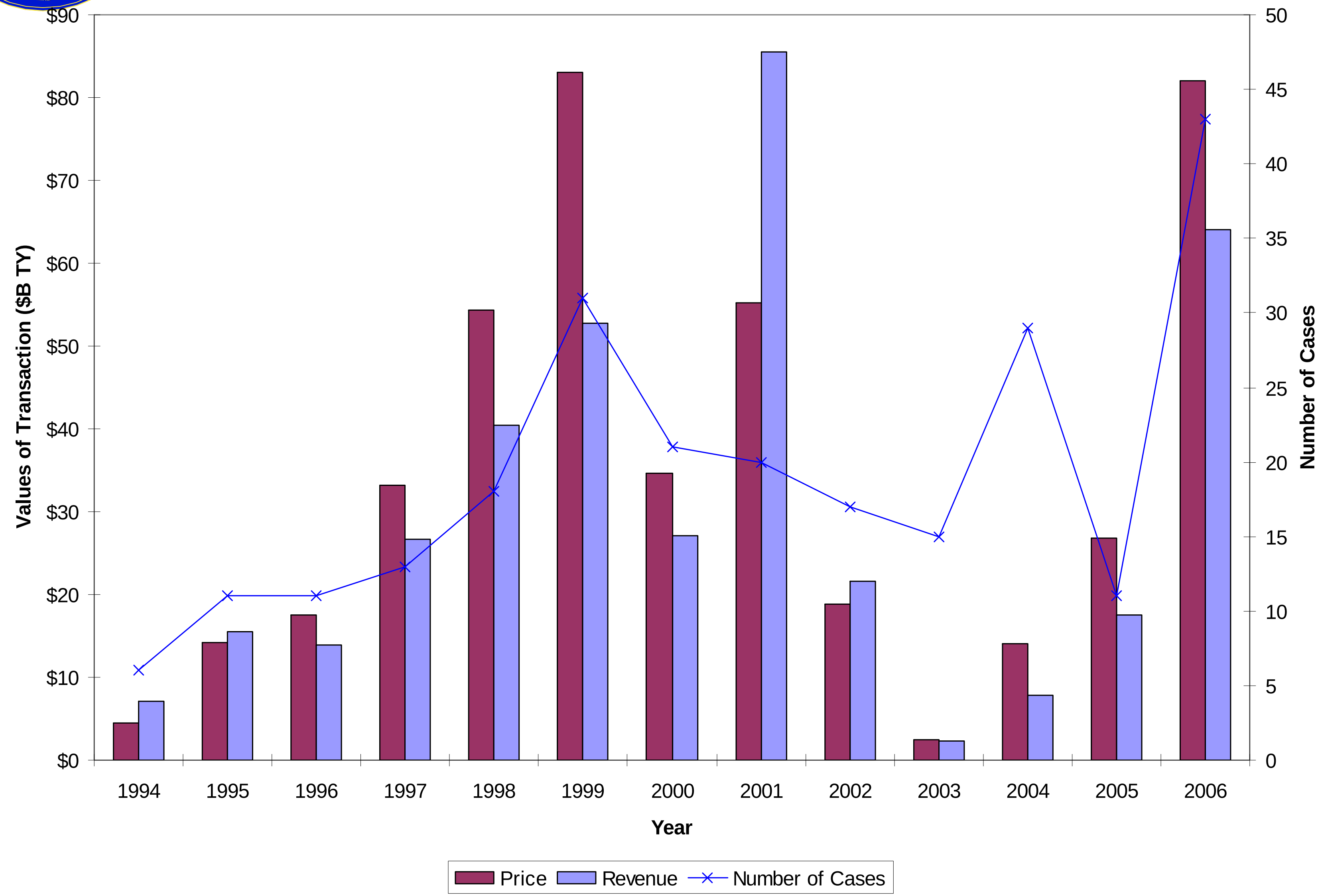
Transactions involving Electronics and IT Dominate both HSR and CFIUS

“Serial Acquirers”

	2003	2004	2005	2006	Total
L-3 Communications	3	4	5	6	18
General Dynamics	6	3	3	4	16
Lockheed Martin	3		2	4	9
Carlyle	2	2			4
BAE Systems		3			3
EDO				2	2
GKN				2	2
Valero			2		2
Armor Holdings		2			2
ATK		2			2
Curtiss Wright		2			2
QinetiQ		2			2
Smiths Aerospace		2			2
Boeing				2	2

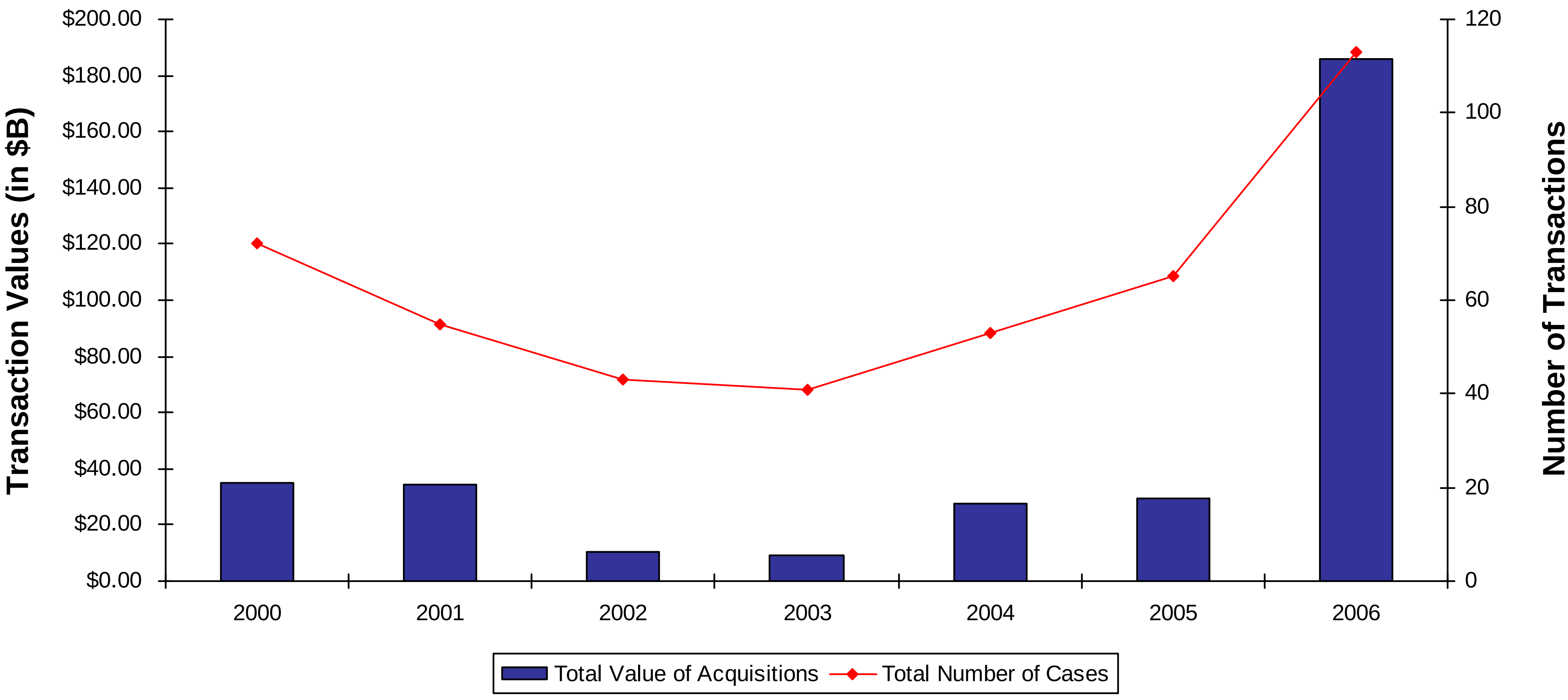
Note: Based on number of transactions the Department chose to examine (if greater than one) in given year.

DoD's M&A Transaction Reviews Increasing



Source: ODUSD(IP) Data 2006 driven by $20B Inco/Falconbridge and $13B Alcatel/Lucent

CFIUS Transactions Also Increasing



CFIUS Acquiring Country Analysis: Top Ten for 2001-2006

Country	# of Acquisitions	% of Total
1. United Kingdom	121	33.7%
2. France	34	9.5%
3. Canada	29	8.1%
4. Germany	17	4.7%
5. Japan	15	4.2%
5. Israel	15	4.2%
7. Australia	14	3.9%
8. Singapore	11	3.1%
9. China	7	1.9%
9. Belgium	7	1.9%
Total Transactions	359	75.2%

UK firms most active in acquiring U.S. defense companies, but CFIUS does not appear to impede cross-border acquisitions by firms from other nations. Non UK/Canada transactions accounted for 58% of all CFIUS filings.

Outline

- Industrial Policy
- Emerging Defense Industrial Environment
- Challenge

Navigating Emerging Industrial Environment

Stagnant/ Declining Defense Spending

Increasing Globalization of Marketplace

Defense-Unique/ Defense-Dominant Technologies/ Equipment

Marginal Business Case?

- Low peacetime quantities
- Companies exiting business
- Little competition
  - Many single/sole sources
  - Minimal innovation incentive

Risk: Future Availability

Examples: fuzes, thermal batteries

Domestic Commercial Capabilities

Production Shifting Abroad?

- Limited ability to influence strategic direction of market
- Security of supply risk
- Tampering potential

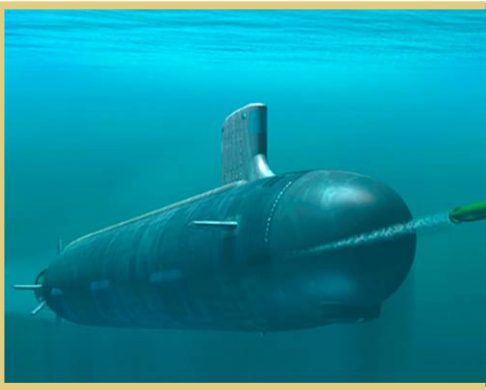
Risk: Future Availability

Examples: software, microelectronics

Stagnant/declining defense spending coupled with increasing globalization is leading to an emerging industrial environment that has significant defense implications.

Naval Open Architecture
Annual Science and Technology Conference



April 18, 2007

Distribution Statement A: Approved for public release; distribution is unlimited.

Captain James Shannon, USN
Program Manager, Future Combat Systems
Open Architecture
PEO IWS 7.0

Captain Jim Shannon

Program Manager, Future Combat Systems

The Navy currently is transitioning to a state of "continuous readiness." Instead of cyclical preparations before deployments, the Global War on Terrorism requires constant operational capability. "Whether it's a warfight or a natural disaster—and they seem to be coming more frequently—we must be much more ready for responding to this very uncertain world than the regimented fashion in the past."

~ Remarks by Adm. Mullen, December 2006

Global trends will continue to impact how we build systems today and in the future

DEFENSE LANDSCAPE

- **Net-centric warfare** requires greater information superiority
- A **1,000-ship Navy** requires a global maritime network of sharing
- The **Global War on Terror** and new emerging threats will shift priorities in the Defense budget

TECHNOLOGY LANDSCAPE

- **Open standards and systems** will surpass closed proprietary systems
- **Service Oriented Architectures** will create new business models that increase competitive pressures on companies
- Exponential rates of advancement in **digital technologies** is facilitating "faster, better, cheaper" production of the global digital infrastructure

BUSINESS LANDSCAPE

- **Intensified competition**, customer expectations, and unexpected market shifts are forcing industry changes
- Traditional approaches to **R&D** will not be sufficient when it comes to fostering and sustaining innovation
- Global connectivity is making new skills and partners accessible to employ which is creating new forms of collaboration and **business models**

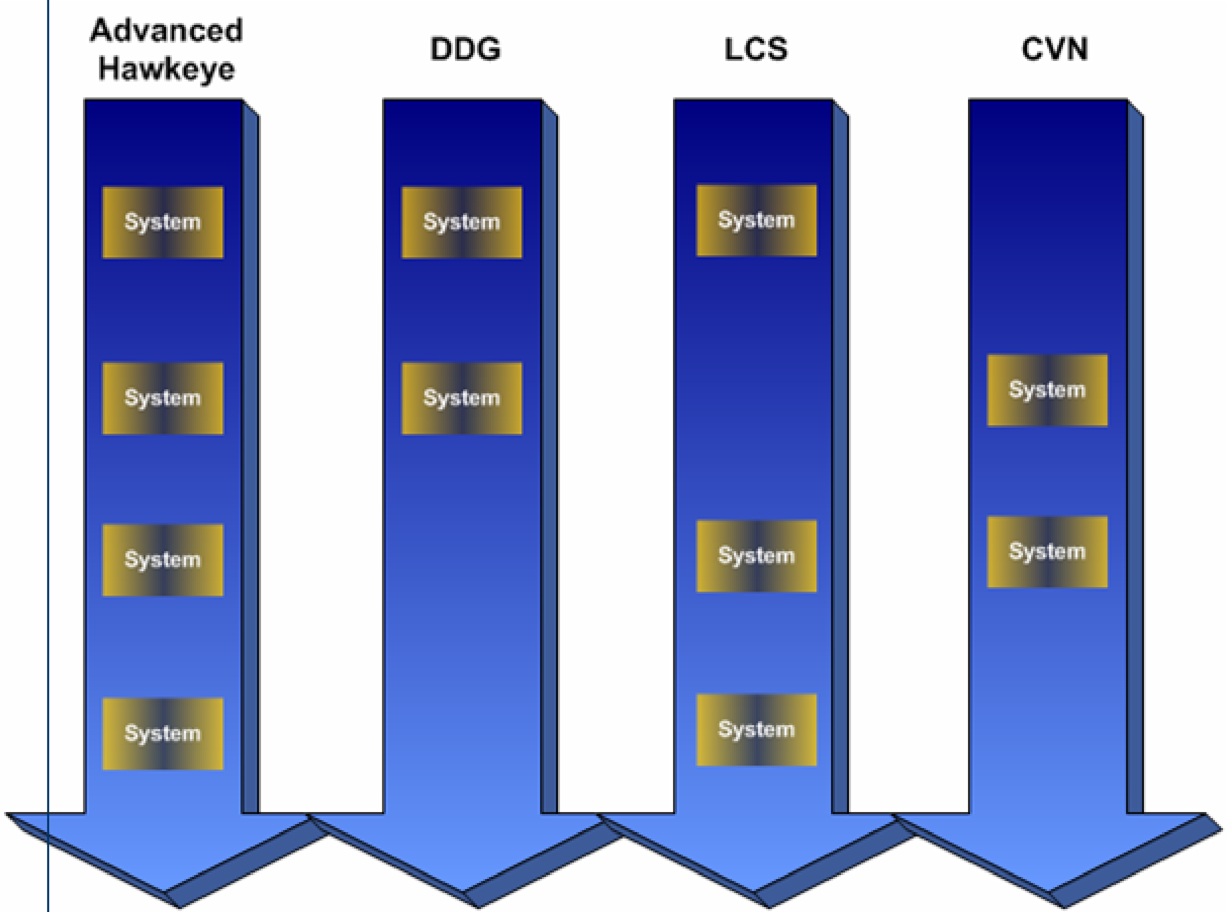
As new operational requirements emerge, we are shifting our acquisition model…

PAST – MILSPEC MODEL

Business Model Attributes:
Platform Focused
Owner controls evolution
Cost emphasis
Develop software
Make custom hardware

System Model Attributes:
Requirements driven
Specification focus
Rigid requirements
Unique / monolithic architectures
Stable design
Ignore evolution
Obsolescence
Waterfall-style development

Platform-focused model



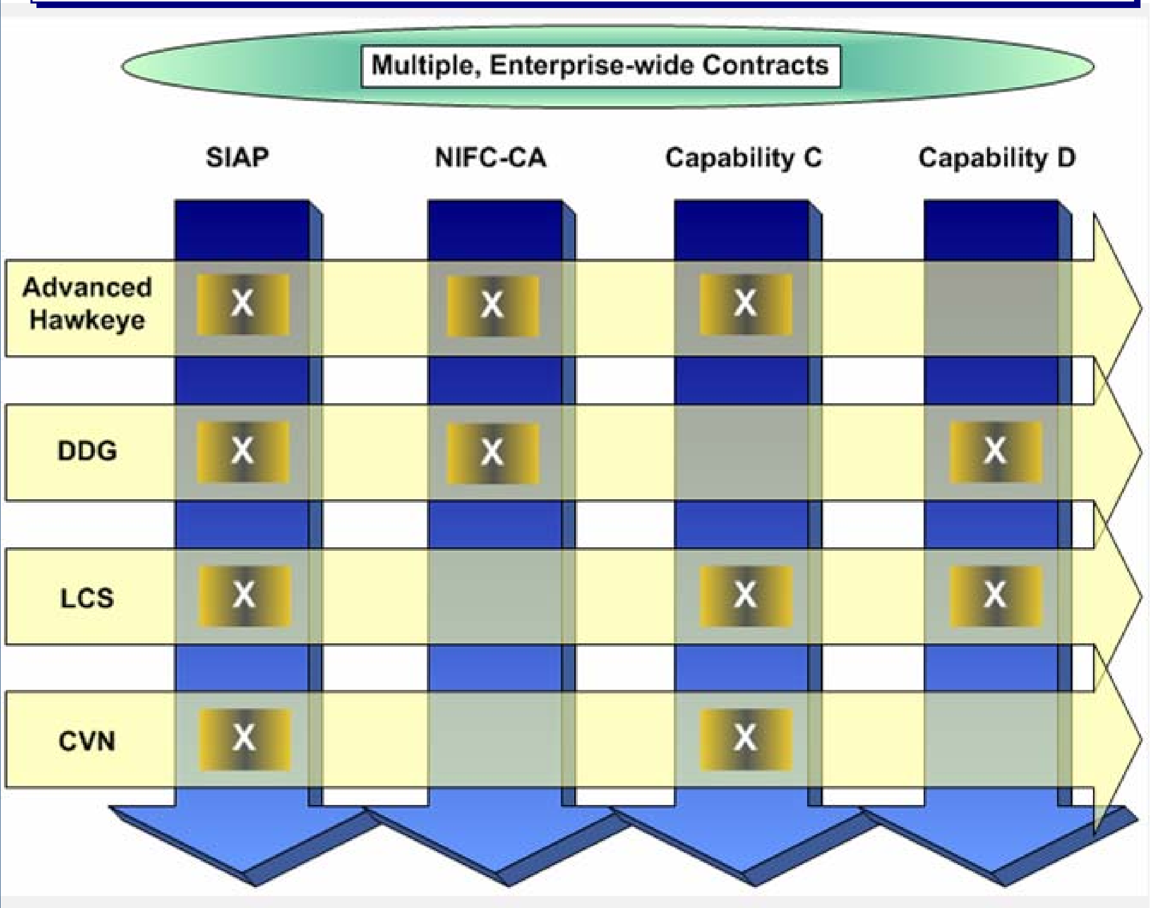
…to a model that better aligns to capabilities across multiple platforms, families of systems, and system of systems

PRESENT – OA MODEL

Business Model Attributes:
Capability / Systems Focused
Market controls evolution
Total Ownership Cost emphasis
License or Reuse software
Leverage COTS or Reuse

System Model Attributes:
Market driven
Business plan focus
Flexible requirements
Modular open architectures
Constant changes
Design for tech refresh
Early-managed obsolescence
Spiral development

Capability / System–Based vice Platform–Based



Our goal is to build and sustain a fleet capable of meeting new and emerging threats while leveraging technology advances

TYPE / CLASS	REQUIRED
Aircraft Carriers	11
Surface Combatants	88
Littoral Combat Ships	55
Attack Submarines	48
Cruise Missile Submarines	4
Ballistic Missile Submarines	14
Expeditionary Warfare Ships	31
Combat Logistics Force	30
Maritime Prepositioning Force	12
Support Vessels	20
TOTAL NAVAL FORCE	**313**

This requires modernizing existing ships to get full service lives…

- It is critical to get full service life from existing ships
  - CG and DDG Modernization
  - LSD 41/49 Mid-Life Program
  - LHA Mid Life

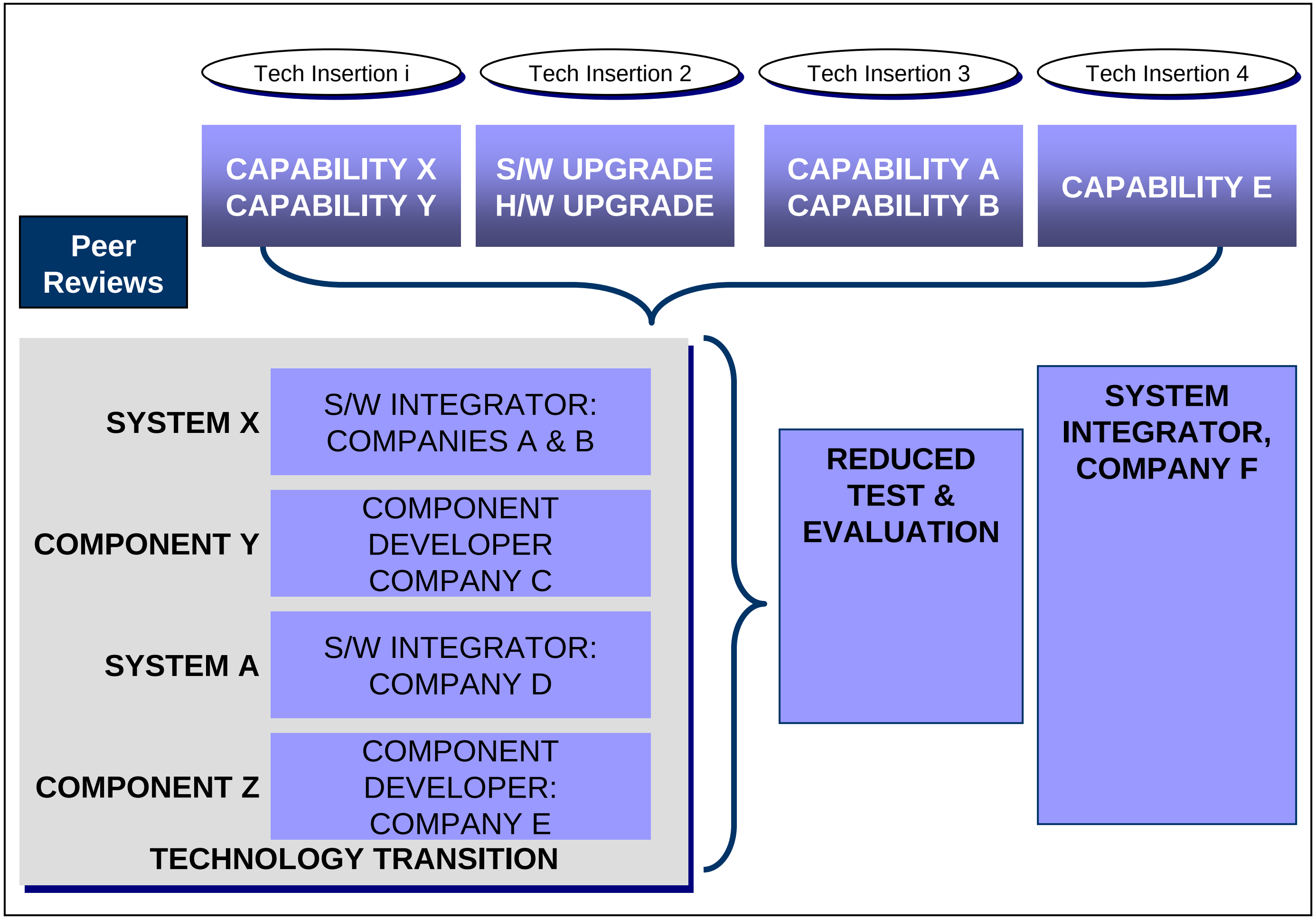
- Avoiding early-retirement requires commitment to keeping these ships relevant

Getting full service lives from existing ships is a critical component of the 313 Ship Plan

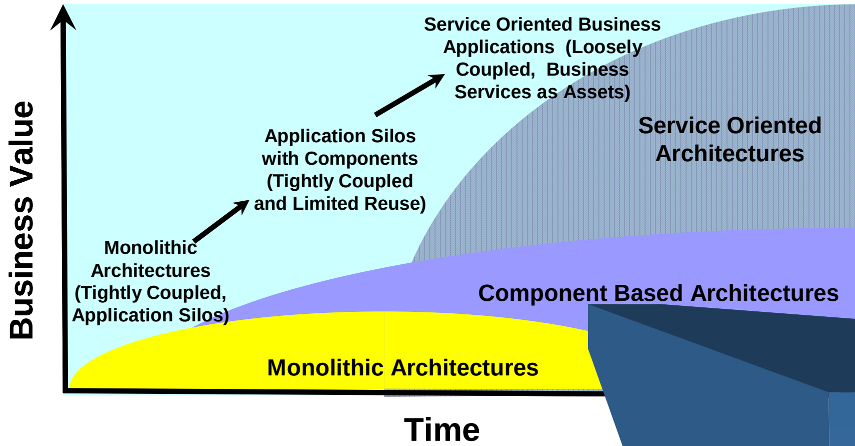
…and enabling the rapid insertion of capabilities from multiple systems and system components at reduced costs

Our process must:

- Identify affordable solutions
- Be open and collaborative
- Enable rapid insertions of new technologies
- Include peer reviews to select best of breed solutions when necessary
- Support component reuse across multiple platforms
- Adhere to DOD regulations

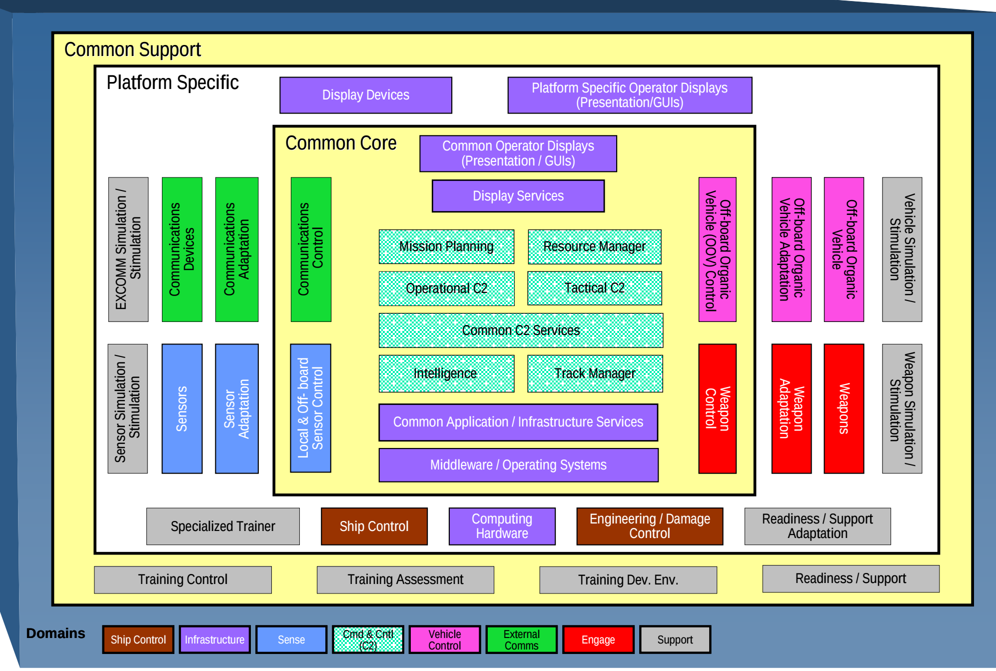


Modular component architectures will be essential to this new model and will impact how we acquire weapon systems

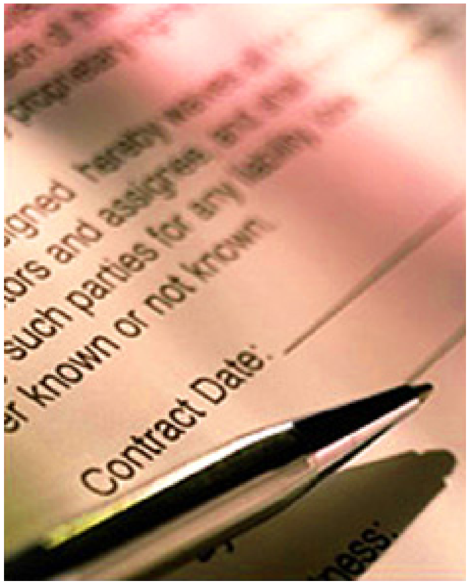


Preliminary Surface Combat Component Architecture

Defining a standard common component architecture is critical for surface ship combat systems in order to identify the major components of surface ship warfighting systems, decompose them, and provide a stable framework into which S&T activities can transition



The key to this new model is changing contracts…



"Our contracts need to be written where we have the ability to have the integrator that is designing the architecture in an open way so we can do competition for various pieces. So [that it is] easier to update with new functionality later on."

- ASN (RDA), Defense Daily , 10 October 2006

We must negotiate to:

- Employ modular architectures
- Allow for components to be decoupled and reused
- Secure appropriate data rights
- Allow for sharing of design artifacts
- Increase the use of peer reviews
- Facilitate tech insertions

"The goal now is to write open architecture requirements into contracts and provide companies incentives to meet the goals."

- ASN (RDA), Defense News , 01 November 2006

…obtaining and enforcing Intellectual Property Rights…

ISSUES WITH INTELLECTUAL PROPERTY RIGHTS

- Programs do not anticipate long-term or enterprise-wide implications when developing their acquisition strategies that address Intellectual Property Rights (IPR)
- Funding is not aligned to build and maintain "families of components" and acquire the appropriate IPR, hindering reuse
- The full impact of IPR often does not manifest itself until programs attempts to upgrade systems, at which point the they learn how IPR restricts upgrade options
- The lack of a clearly defined IPR strategy before contract award complicates system certification. Procurement documents must clearly specify how the Navy will get access to source code and related information and that these materials must reside with the government for an unlimited amount of time to allow for system certification and other purposes.

We strive for Government Purpose Rights (GPR) in contracts to facilitate movement towards common solutions and reuse among systems …

… However, we will accept more restrictive rights when the business case warrants and allow proprietary solutions to ride on the Navy-owned architecture.

…and reducing Testing & Evaluation costs and schedule—beta testing is one method under review

- Beta Testing, or elements thereof, can provide benefits
  - Information Advantage: greater range of data; useful data earlier in development
  - Time Advantage: Shortened schedule or more efficient use of available time
  - Cost Advantage: Contribute to reduced testing costs

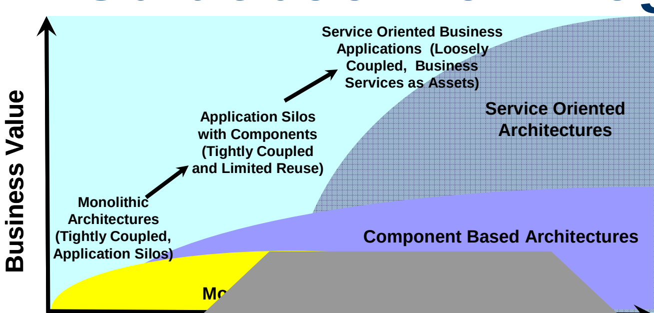
- Beta-like activities have been used primarily to contribute to broader testing programs that usually include formal TECHEVAL and OPEVAL

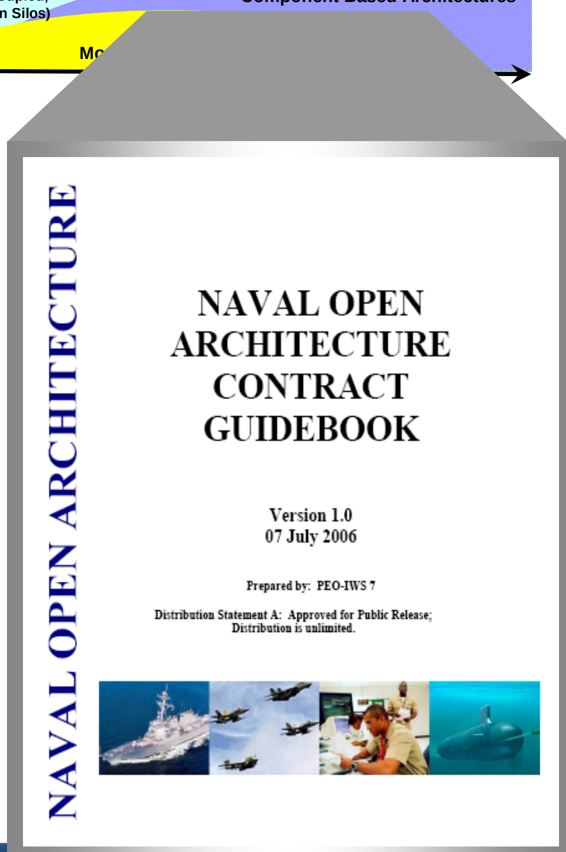
- Beta-like activities tend to be most appropriate for :
  - Smaller programs: i.e. ACAT III, ACAT IV, and non-ACAT programs
  - Information-technology items
  - Items that are largely COTS or GOTS
  - Upgrades, spiral developments, or incremental developments

- Beta Testing is not appropriate for full range of Navy Testing
  - It is not suitable for wartime systems, safety systems, emergency equipment
  - It cannot substitute formal DT/OT data in satisfying formal testing needs but can supplement that data and reduce requirements for collection of formal testing data

Source: Center for Naval Analyses, "Minimally Supervised User Testing: The Potential for Exploiting Beta Test Practices Within Integrated Testing"

In July 2006, PEO IWS released the Naval OA Contract Guidebook for Program Managers to support this model





NAVAL OPEN ARCHITECTURE

NAVAL OPEN ARCHITECTURE CONTRACT GUIDEBOOK

Version 1.0
07 July 2006

Prepared by: PEO-IWS 7

Distribution Statement A: Approved for Public Release;
Distribution is unlimited.

The Guidebook is primarily for development contracts for component based architectures and includes:

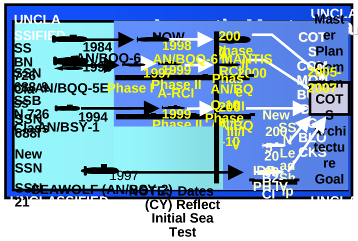
- Recommended language for Sections C, L, and M
- Recommended award fee criteria for “Performance and Schedule” and “Work Relations”
- Appendices:
  - Recommended Naval OA Contract Data Requirement List (CDRL) and deliverable items
  - Recommendations for assessing a program’s intellectual property rights needs
  - Recommendations for using Small Business Innovation Research contracts to support Naval OA goals
  - Naval OA “Quick Checklists” to help drafters and reviewers

There are challenges we must address as we transition to our new model to keep pace with global trends

- Securing the appropriate **intellectual property rights** for system design artifacts and components to support design disclosure and reuse

- Negotiating affordable **licensing agreements for COTS software products** across several programs to reduce lifecycle costs
  - Determining what the licensing fees will be
  - Determining how many seats / platforms will require the software
  - Determining organizational responsibilities for negotiating enterprise-wide licenses

- **Balancing performance and schedule** vice changes in technology and system development



- **Overcoming** organizational and industry **resistance** to new models

Beyond OA, there are new approaches to building systems that we must begin to better understand - SOA

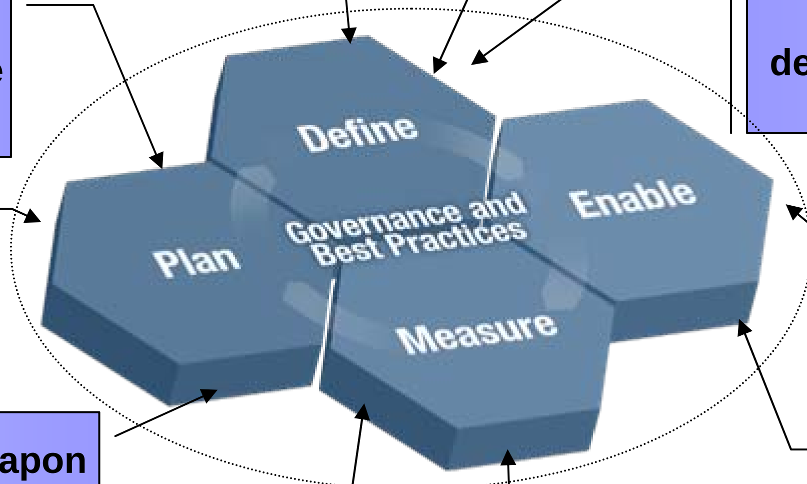
4 What standards do we need to establish and when?

5 What processes do we need to identify, develop, deploy and manage services?

3 How do we govern and manage the Life Cycle of services?

6 How do we govern and manage our SOA Identification, development and deployment approach?

2 How do we handle SOA and Information Assurance reqs?



7 What metrics and key performance indicators will we use?

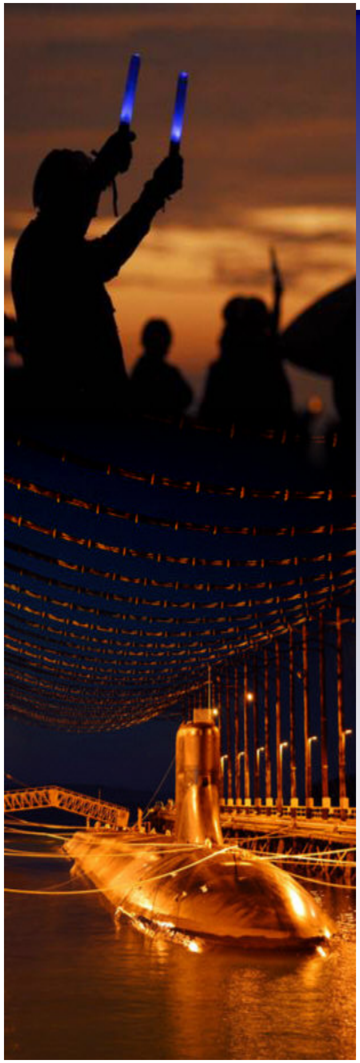
1 How will SOA impact weapon systems? What is our SOA strategy?

8 How does the registry and repository get used? What controls are necessary?

10 How do we measure our model and the effectiveness of services?

9 Who manages the Services Repository? Who uses it?

We do not know what the future holds but we do know that insight which will prevail over many years is a challenge



Although many leaders have been successful, some of their predictions have been proven wrong!

“I think there is a world market for maybe five computers.”
Thomas Watson, chairman of IBM, 1943

Even if a submarine should work by a miracle, it will never be used. No country in this world would ever use such a vicious and petty form of warfare!“ - William Henderson, British admiral(1914)

“Computers in the future may weigh no more than 1.5 tons. ”
Popular Mechanics, 1949

Another popular fallacy is to suppose that flying machines could be used to drop dynamite on an enemy in time of war. - William H. Pickering, 'Aeronautics,' 1908

“640K ought to be enough for anybody. ” Bill Gates, 1981

If we are to keep pace with new fleet requirements and global trends we must be able to quickly adapt our acquisition models

- In summary, we must:
  - Align our model to support capabilities across multiple platforms, families of systems, and system of systems
  - Change our contracts to enable the capability to quickly upgrade systems and leverage technology advances at reduced costs
  - Obtain and enforce intellectual property rights
  - Change our culture and align our industry partners
  - Explore avenues to reduce T&E cost and schedule
  - Gain a better understanding of future system development approaches that will impact how we build and sustain systems today

Surface • Submarines • Air • Space • C4I

Naval Open Architecture

Enterprise Team

The guidebook includes recommended language to help the Navy advance towards open modular systems

Key Requirements for Contractors	
Define and follow an open systems approach	Employ open, published standards
Develop an open layered, modular architecture	Define interfaces between modules, components, and subcomponents
Describe rationale for modular choices	Limit use of proprietary or vendor-unique elements
Ensure system requirements are accounted for	Negotiating appropriate intellectual property rights and patent rights
Document and model the component	Reusing pre-existing or common components
Minimize inter-component dependencies	Supporting third-party development to foster collaboration and competition
Support rapid, affordable technology insertions	Promote the identification of multiple sources of supply and promote flexible business strategies
Use Commercial-Off-the-Shelf (COTS) products	

Changes in legislation will also impact our acquisitions

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

JAN 1 8 2007

ACQUISITION, TECHNOLOGY AND LOGISTICS

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
ATTENTION: SERVICE ACQUISITION EXECUTIVES
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Limitations On Contractors Acting as Lead System Integrators

This memorandum implements section 807 of the John Warner National Defense Authorization Act for Fiscal Year 2007, Public Law 109-364. Effective for contracts entered into after December 31, 2006, no entity performing lead system integrator functions in the acquisition of a major system by the Department of Defense may have any direct financial interest in the development or construction of an individual system or element of a system of systems. This applies to lead system integrators as defined in section 805 of the National Defense Authorization Act for Fiscal Year 2006:

"Lead system integrator with system responsibility" means a prime contractor for the development or production of a major system if the prime contractor is not expected at the time of award to perform a substantial portion of the work on the system and the major subsystems.

"Lead system integrator without system responsibility" means a contractor under a contract for the procurement of services whose primary purpose is to perform acquisition functions closely associated with inherently governmental functions with regard to the development or production of a major system.

When the acquisition strategy calls for use of a lead system integrator for a major system, contracting officers shall address whether the contractor has a direct financial interest in the development or construction of an individual system or element of a system of systems when making the responsibility determination. The offeror may be considered eligible for award of a contract if it has no direct financial interest in development or construction of an individual system or element of a system of systems. If the offeror has such a direct financial interest, the contracting officer may request an exception from the Secretary of Defense. The request will be submitted to the Deputy Director, Program Acquisition and International Contracting, and it must explain that:

1. The offeror was selected to develop or construct the system or element concerned through the use of competitive procedures and that appropriate steps were taken to prevent any organizational conflict of interest; or

Limitations on Contractors Acting as Lead System Integrators

- No entity performing lead system integrator functions in the acquisition of a major system by the Department of Defense may have any direct financial interest in the development or construction of an individual system or element of a system of systems effective for contracts entered into after December 3 1,2006
- "Lead system integrator with system responsibility" = a prime contractor for the development or production of a major system if the prime contractor is not expected at the time of award to perform a substantial portion of the work on the system and the major subsystems.
- "Lead system integrator without system responsibility" = a contractor under a contract for the procurement of services whose primary purpose is to perform acquisition fictions closely associated with inherently governmental functions with regard to the development or production of a major system

Armament Research, Development and Engineering Center

Presentation to
2007 NDIA S&T Conference
(17-19 April 2007)
by

Dr. Joseph A. Lannon
Director, ARDEC
Picatinny Arsenal, NJ 07806-5000

Armament Research, Development and Engineering Center (ARDEC)

Vision:

Innovative Armaments Solutions for Today and Tomorrow

Mission:

Provides fully integrated life cycle engineering (from R&D to demil) for armaments and munitions in support of the Army, Program Executive Offices, the Single Manager for Conventional Ammunition, Air Force, Navy, Marines, Coast Guard and Special Operations Forces

Advanced Weapons – line of sight/beyond line of sight fire; non line of sight fire; scalable effects; non-lethal; directed energy; autonomous weapons
Ammunition – small, medium, large caliber; propellants; explosives; pyrotechnics; warheads; insensitive munitions; logistics; packaging; fuzes; environmental technologies and explosive ordnance disposal
Fire Control – battlefield digitization; embedded system software; aero ballistics and telemetry

Provides the Technology for Over 90% of the Army's Lethality; Significant support to other Services Lethality

FCS Key Initiatives

- **S&T Successfully Transitioned Key Armament Technologies to FCS**
  - **LOS/BLOS Armament**
  - **NLOS-M**
  - **MRM**

- **Successful Partnership with LSI for SDD Armaments**

- **ARDEC Meeting and Exceeding LSI Expectations**

120mm LOS/BLOS S&T ATD

PROBLEM:

105mm weapon systems could not provide lethality necessary to defeat the next generation Main battle tank; existing 120mm systems worldwide too heavy and not integratable onto a preferred 20 ton class vehicle

SOLUTION:

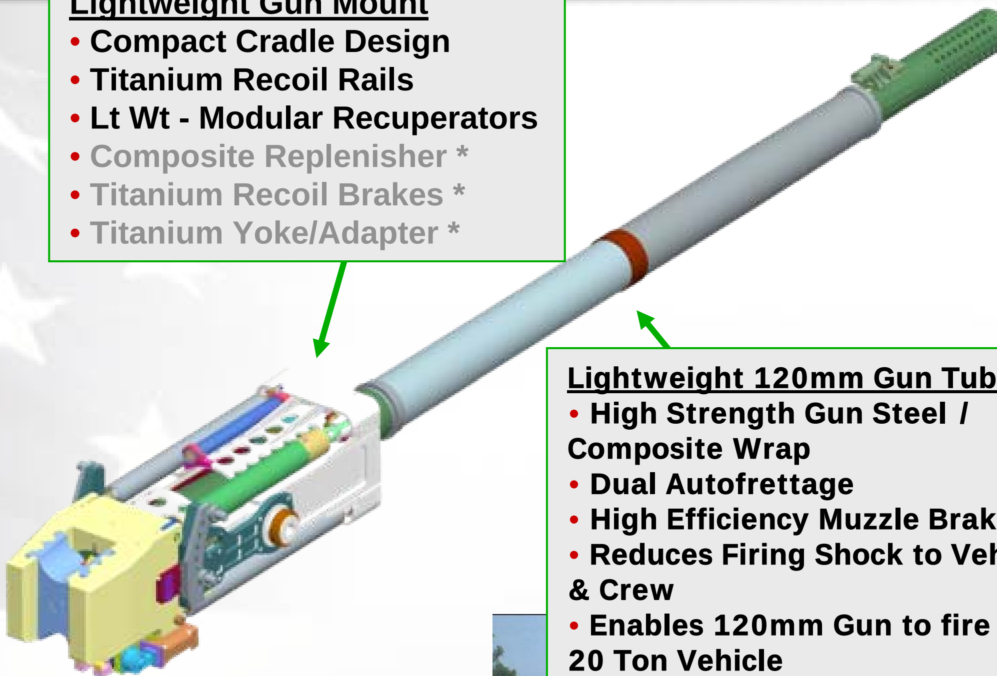
- Produced Lightweight 120mm Gun Assembly
  - Initial Proof-of-Principle Gun designed, built, fired in 13 months, compared to 24 month average
  - Gun Assembly Wt. ~ 4200 lbs. as compared to M256 Abrams 120mm main armament – 6800 lbs.
  - Reduced gun firing impulse for integration in 20 Ton class vehicles, 5300 lb-sec vs. 7000 for M256
  - Ability to fire both current & developmental 120mm rounds – 5 current rounds + 3 new rounds
- Developed enabling fabrication techniques
  - New steel w/ 20% higher yield strength
  - Integrated muzzle brake, saves ~200 lbs in gun weight
  - Lighter Composite over wrapped gun tube (lower weight without loss of pressure containment, over 35% lighter than the M256

120mm LOS/BLOS Transition to Mounted Combat System (MCS)

Primary Weapon
for Mounted Combat System

- Provides direct fire in support of forces in the Unit of Action (UA).
- Beyond Line-of-Sight (BLOS) capability to 12 km with Medium Range Munitions (MRM).
- All the Performance of Current 120mm Cannon in a Light Weight, Compact Design
- Over 2,000 lbs lighter than 120mm Gun used on Abrams Tank
- Muzzle Brake & Recoil System Design Enables a 120mm Gun to fire from a 20 Ton Vehicle.

Lightweight Gun Mount
- Compact Cradle Design
- Titanium Recoil Rails
- Lt Wt - Modular Recuperators
- Composite Replenisher *
- Titanium Recoil Brakes *
- Titanium Yoke/Adapter *



Lightweight 120mm Gun Tube
- High Strength Gun Steel / Composite Wrap
- Dual Autofrettage
- High Efficiency Muzzle Brake
- Reduces Firing Shock to Vehicle & Crew
- Enables 120mm Gun to fire from 20 Ton Vehicle

Multi-Lug Breech Mechanism
- Long Life, Compact, Light Weight
- 600VDC Electrically Actuated
- Ammo Data-Link Enables Communication to Smart Rounds
- Electro-Thermal Ignition *

Gun Technology Demonstrated on Over 730 Rounds of Live Fire Testing on various iterations

* *Technologies not transitioned*

GENERAL DYNAMICS
Land Systems

ARDEC Science & Technology Objective LOS / BLOS Technology Video

ATD for 120mm LOS/BLOS Armament:

- Successfully completed in FY05 and transitioned to LSI

- ARDEC is providing SDD engineering, design and hardware for the primary weapon assembly to LSI under CRADA

- Timeframe Oct 2005 – Jan 2013; $71.1M

ARDEC's Objective NLOS-M Technology Development

PROBLEM:

No existing mortar system, US or foreign, could meet the FCS NLOS-M threshold requirements for lethality, range, and rate fire using existing family of ammunition at target weights

SOLUTION:

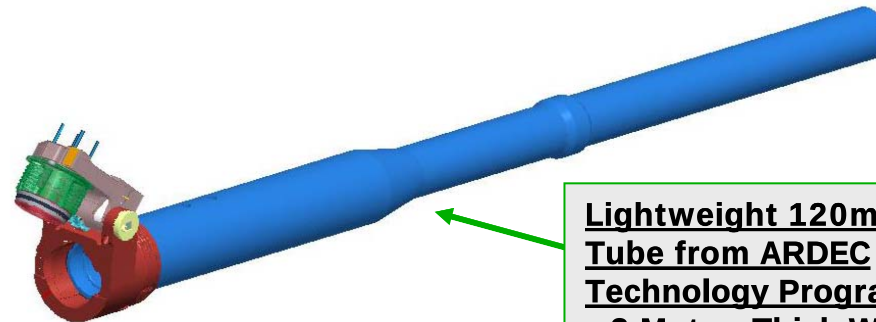
- Produced Breech Loading 120mm Mortar and demonstrated FCS required technologies
  - Ability to fire both current & developmental 120mm mortar rounds with no ammunition modification or expendable devices at threshold rates of fire. No competitive system could do this
  - Thick walled mortar tube provides passive tube cooling
  - Fast acting screw block breech, based on artillery designs
  - Three ammunition position & retention technologies to ensure proper loading and firing
  - Innovative out of line firing pin to permit safe loading
  - Mortar Assembly (including mount) Wt. ~ 1200 lbs. compared to competitive systems 1900 to 2900 lbs. Weight was not optimized in this program.
  - Turret, mount, & ammunition handling systems developed to support demonstration
  - Demonstrated 12 RPM firing

ARDEC's Technology Transitioning to 120mm XM325 Non Line of Sight Mortar

Primary Weapon

for Future Combat System NLOS-M

- **Mortar developed under ARDEC Science & Technology Objective program.**
- **Provides breech loaded 120mm mortar capability. DEMONSTRATED**
- **Non Line-of-Sight (NLOS) capability to 8 km with unmodified M900 series mortar ammunition. DEMONSTRATED**
- **Can fire 16 rounds per minute, 8 rounds per minute sustained. 12 rounds per minute DEMONSTRATED**



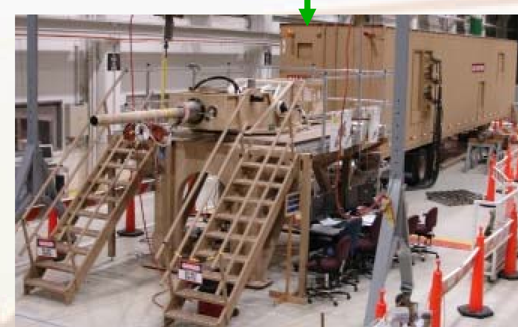
Lightweight 120mm Gun Tube from ARDEC Technology Program
- **3 Meter ,Thick Wall Tube**
- **High Strength Gun Steel**

Screw-Block Breech Mechanism from ARDEC Technology Program
- **Modified for NLOS-M System Integration.**
- **Incorporates one ARDEC Ammunition Retention Technology**
- **Integrates with BAE Mount, Ammunition Loading, Round Retention, Firing Mechanism, & Actuation Devices ***

NLOS-M Firing Platform (BAE)
- **ARDEC's XM325 EP1 has successfully integrated on the NLOS-M Firing**
- **Firing Tests by BAE are underway**

BAE SYSTEMS

** Technologies not transitioned*



ARDEC Science & Technology Objective NLOS Mortar Technology Video

XM325, Cannon, 120mm Mortar, Breech Loading:

- Successfully completed in FY06 and transitioned to LSI
- ARDEC is providing SDD engineering support, design and hardware for the 120mm cannon assembly to LSI under CRADA
- Timeframe Oct 2006 – Mar 2011; $4.1M

Mid Range Munition (MRM) for the FCS Mounted Combat System

PROBLEM:

The FCS MCS required an extended range, heavy armor target engagement capability to increase the lethality and survivability of the system.

MRM SYSTEM CHARACTERISTICS:

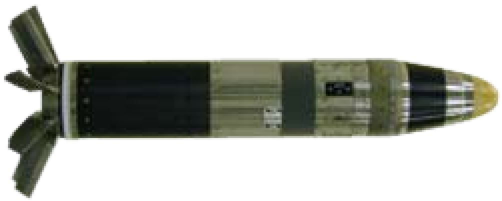
- **Precision Munition for FCS MCS Vehicle**
- **Designed to Defeat High Pay-Off, Fleeting Targets (MBTs with ERA, APCs, Artillery, etc.)**
- **Incorporates Autonomous and Designated Mode Seekers**
- **Operates in Line-of-Sight or Beyond Line-of-Sight from 2km out to 12Km**

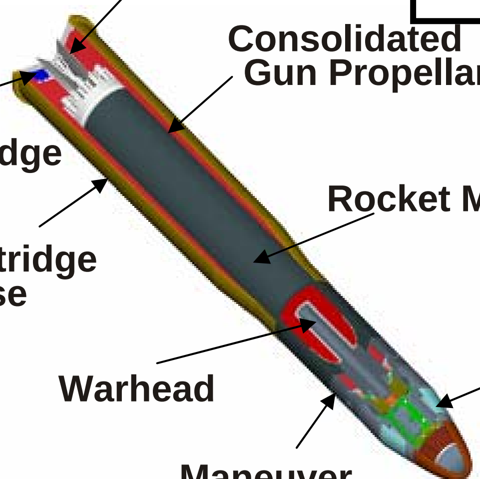
SOLUTION:

The MRM provides the FCS Mounted Combat System (MCS) with a precision munition capable of defeating LOS/BLOS threats out to 12km.

Mid-Range Munition
ARDEC S&T is developing two competing concepts with industry partners Raytheon and ATK

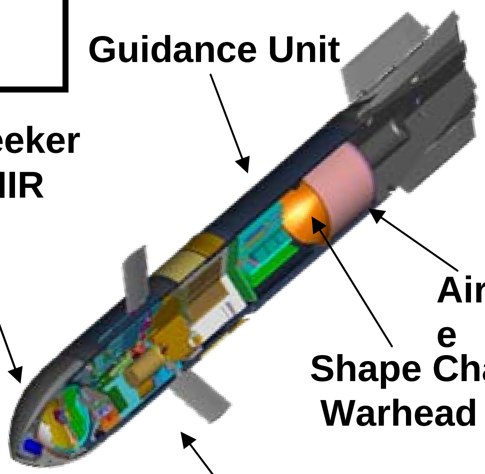
MRM-KE





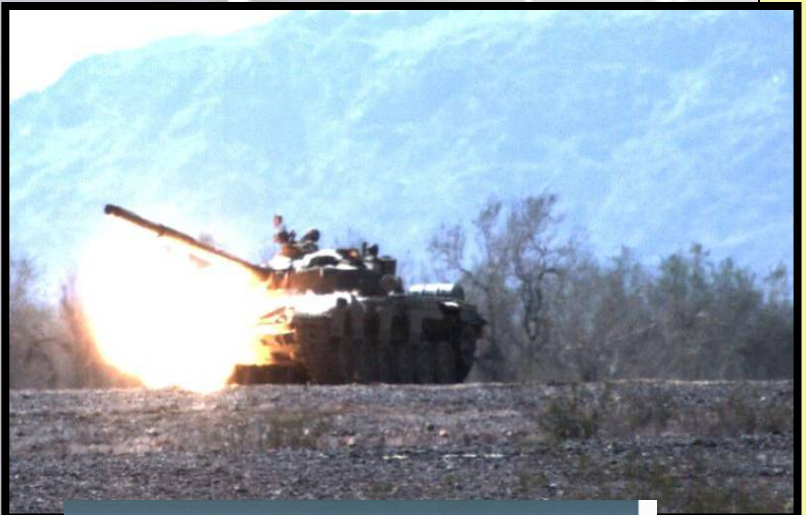
- **Target Types**
  - Main Battle Tanks (MBT) w/ ERA
  - Light Armor (BMP)
  - Self Propelled Artillery (SPH)/(MRL)
  - Air Defense Artillery (ZSU)
  - Bunkers (Earth & Timber)
- **Attributes**
  - Fleeting High Payoff Targets
  - Single Point Defeat
  - Stationary or Moving (Fleeting)

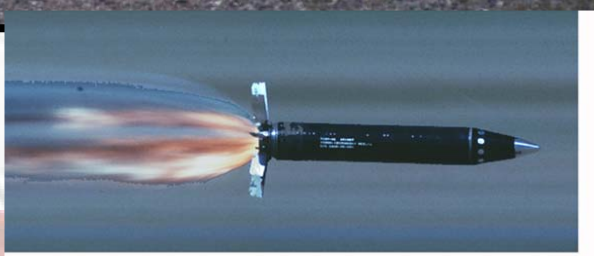
MRM-CE



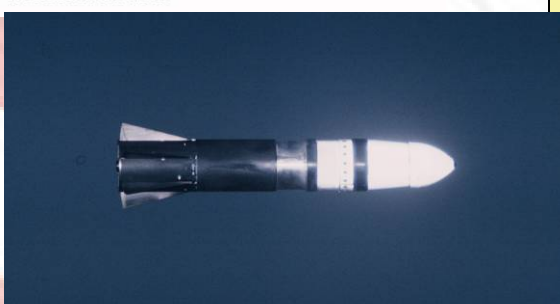
Program has Achieved Autonomous, SAL, and Dual Mode TRL 6!

MRM Technology Status





Smear from Round #109

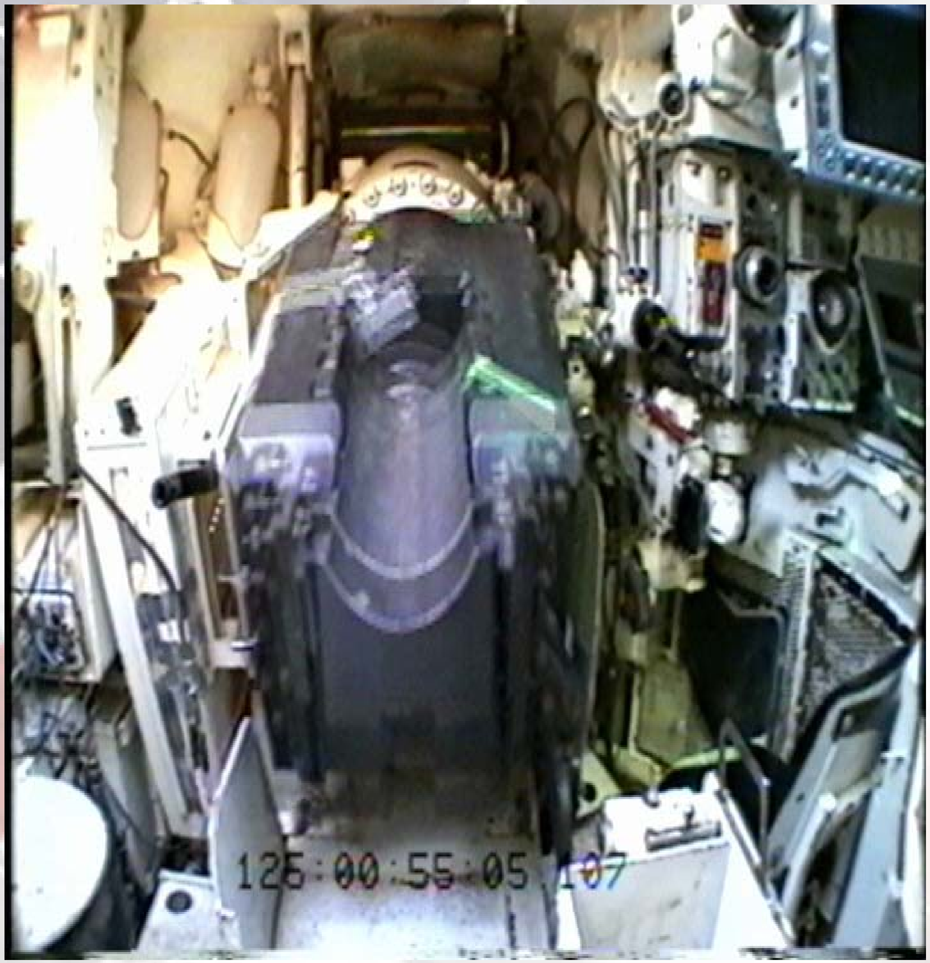


MRM has demonstrated TRL6 for:

- ☑ All major Subsystems
  - Warhead
  - Airframe
  - Propulsion
  - G&C
  - Seeker
- ☑ Integrated Autonomous Seeker Guide to Hit - 2004
- ☑ Integrated SAL Seeker (Designate) Guide to Hit - 2006
- ☑ Integrated Dual Mode Seeker (Autonomous & SAL) Guide to Hit - 2007

ARDEC Science & Technology Mid-Range-Munition (MRM) Video

MRM CE – Semi Active Laser Designated



MRM CE - Autonomous Mode

Complete rounds fired except for warhead. Space was used for telemetry. Lethality demonstration was done separately. Full up round firing will occur during SDD

In Summary…

- ARDEC successfully developed Armament Technologies for FCS
- Successfully transitioned from S&T
  - LOS/BLOS 120mm Armament
  - NLOS-M cannon assembly
  - Expect to transition MRM 1QFY08
- ARDEC has successful partnership with LSI contractors to continue development in SDD

…..Continued Dialog to Maximize Collaboration Opportunities

Office of the Director, Defense Research & Engineering

The Joint Capability Technology Demonstration (JCTD) Program

8th Annual NDIA Science and Engineering Technology Conference/ DOD Tech Expo

Mr. John J. Kubricky

DUSD(AS&C)

17 April 2007

DDR&E/AS&C Mission

OSD / Advanced Systems & Concepts

- Find, demonstrate and transition the operational concepts and technologies that meet **<u>Joint and Coalition Warfare Needs</u>**
- Leverage RDT&E Defense-wide resources through partnerships with Services and Agencies to meet the **<u>Most Critical</u>** needs of the joint warfighter as defined by **<u>Combatant Commanders</u> (COCOMs)**
- **<u>Induct Innovative Technologies</u>** inside the traditional Planning, Programming, Budgeting, and Execution (PPBE) process that result in an enduring **<u>Capabilities-based Portfolio</u>** to defeat asymmetric threats

Thrusts: Agile, Adaptive, Affordable, Relevant, Urgent, Enduring, Transition

AS&C: Inside Statutory Budget Process

OSD / Advanced Systems & Concepts

Needs Process

1. Develop & specify needs
2. Review budget-based programming and acquisition solutions
3. Allocate resources to commanders

Needs Roles

CJCS/JCS
COCOMs
Joint Staff
Military Staffs
COCom/Component Cdr Staffs

Acquisition Solutions Process

1. Consult with needs authorities in solution development
2. Acquire material solutions
3. Deliver resources for allocation to joint/combatant commanders

Solution Roles

USD (AT&L)/DAE
Service Secretaries/SAEs
OSD (AT&L) Staff
Service Secretariat Staffs
Systems/Materiel Commands
Military Agencies

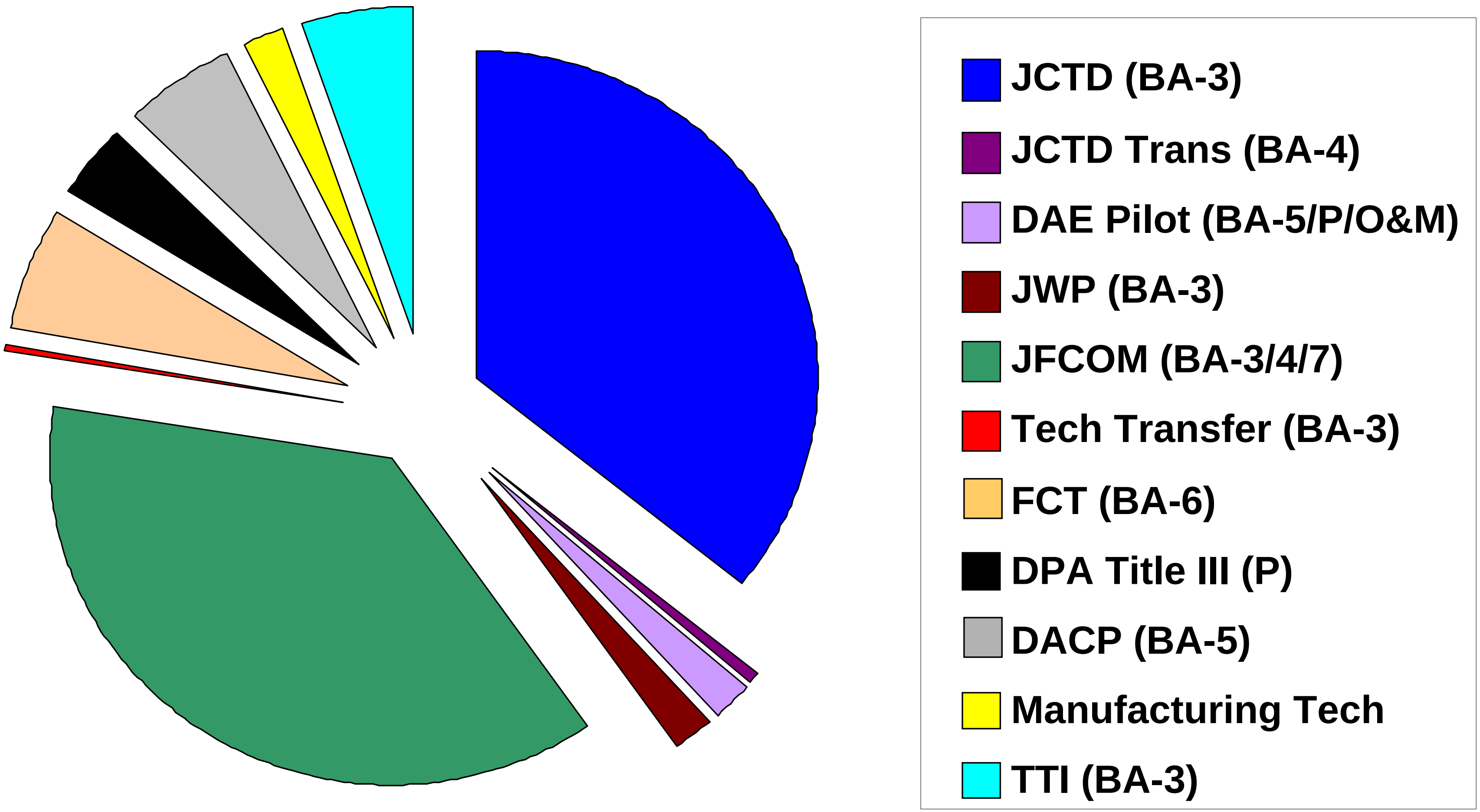
PPBE: Program – Budget Process

FY 2008 DDR&E/AS&C Oversight

FY 2008 PRESBUD (Feb 2007)

OSD / Advanced Systems & Concepts

Total Current Estimate: $540.018M



Source: FY 2008 PBR

FY 2008 RDT&E President's Budget Request

OSD / Advanced Systems & Concepts

DDR&E/AS&C Transition Programs are Highly Leveraged across Service & Agency Budgets, *but are less than 1% of DoD RDT&E each year*

Components (All RDT&E)	$B
USA	10.59
USAF	26.71
USN/USMC	17.08
Def Agency & SOCOM	20.74

(BA6 + BA7 = $30.59B)

Development (BA4 + BA5 = $33.76B)

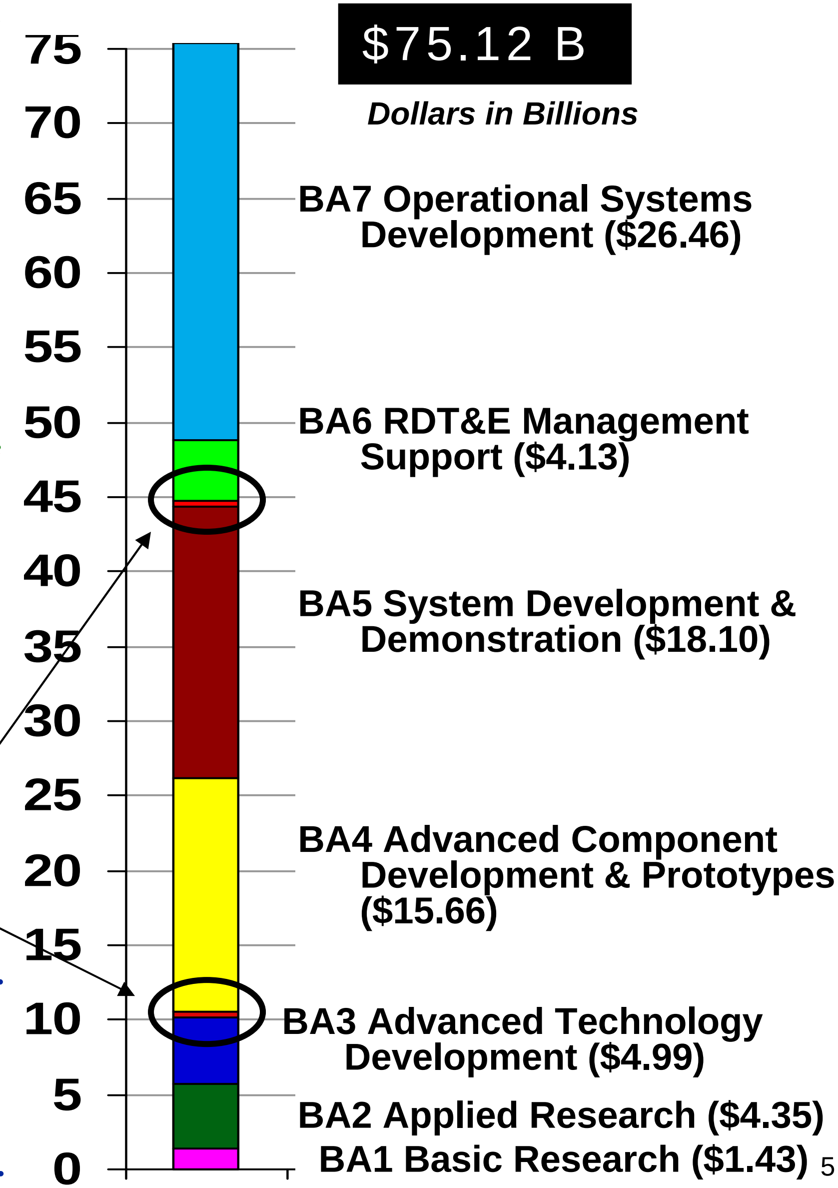
DDR&E/AS&C Total = $0.540 B

(BA3/4 $0.398; BA4/5/6 - $0.122)

(Includes USJFCOM $0.202B)

Technology Base (BA1 + 2 = $5.78B) - **Science and Technology (BA1 + BA2 + BA3 = $10.77B)**

14% of RDT&E



The AS&C Portfolio

OSD / Advanced Systems & Concepts

6.1	6.2	6.3	6.4	6.5	6.7	Proc	O&M

Science & Technology — Research & Engineering

TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9

Concept & Technology Development — A — B — System Development & Demonstration — C — Production & Deployment — O&M

Initial Product/ Process Capability — *Product/Process Development* — *Product/Process Insertion* — *Product/Process Improvement & Sustainment*

COCOM /Joint/Coalition focused — *ACTD/JCTDs* — ***Demo 1-4 yrs***

AC/JCTDs Transition Enabler – "joint peculiar" capabilities — *JCTD Transition & DAE Pilot Program*

Industry "On" Ramp – Test to Procure Tech Refresh — *Defense Acquisition Challenge*

Service, SOCOM Nominated - Test to Procure — *Foreign Comparative Testing*

Congressionally Directed — *Tech Transition Initiative* — ***DOD Lab Tech Push***

DoD Technology Transfer — *TechLink* — ***to Private Sector***

JFCOM as Joint Force Integrator — *Joint Warfighting, Experimentation, & Integration*

Domestic Technologies Critical to National Security — *Defense Production Act (Title III)*

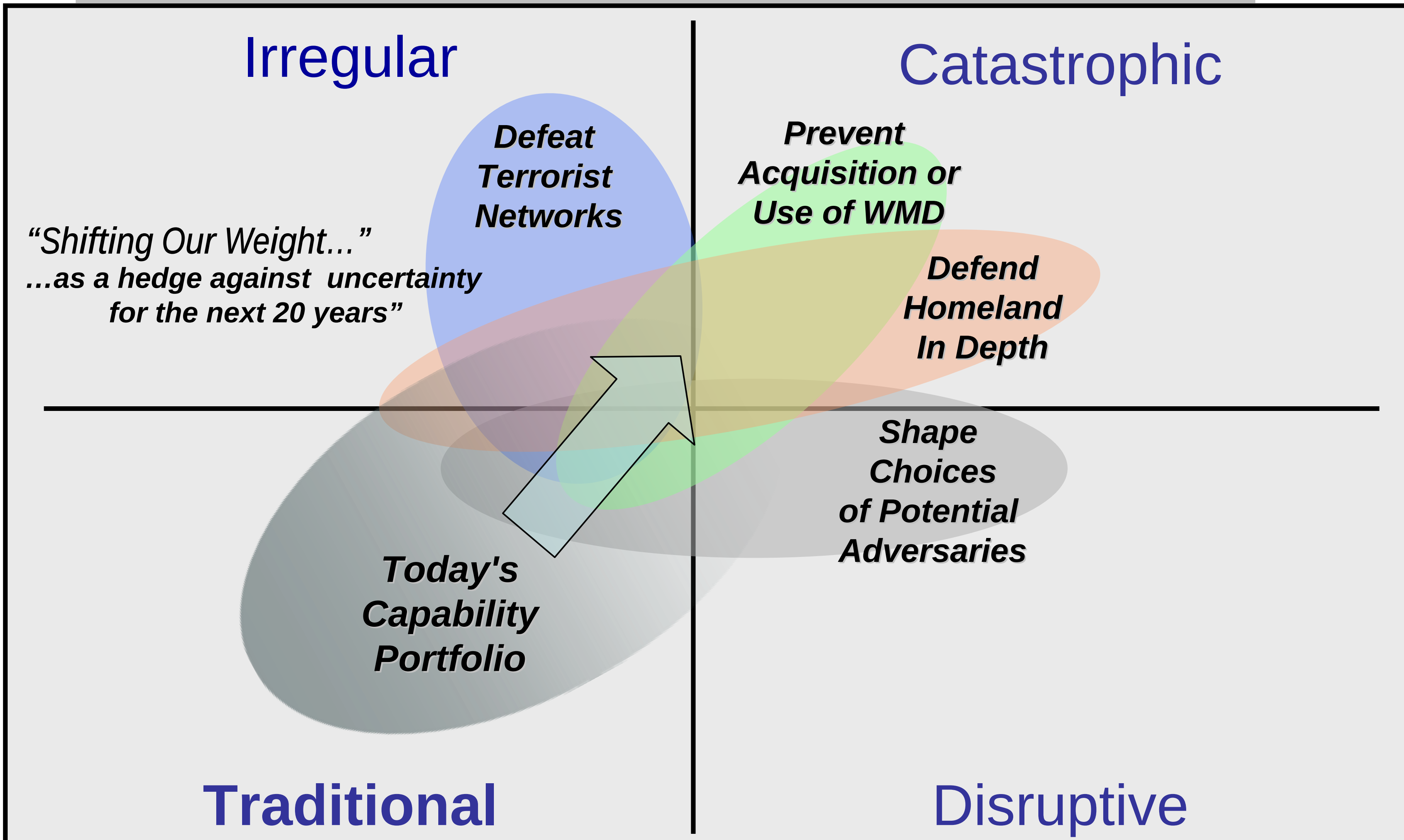
ManTech Joint Investments — *Manufacturing Technology (Service and OSD funded)*

Industry's Edge — *Independent Research & Development (Contractor Reimbursable Funding)*

Note: Grey indicates industry funding; OSD oversight

21st Century Paradigm for COCOMs

OSD / Advanced Systems & Concepts



Characteristics of JCTDs

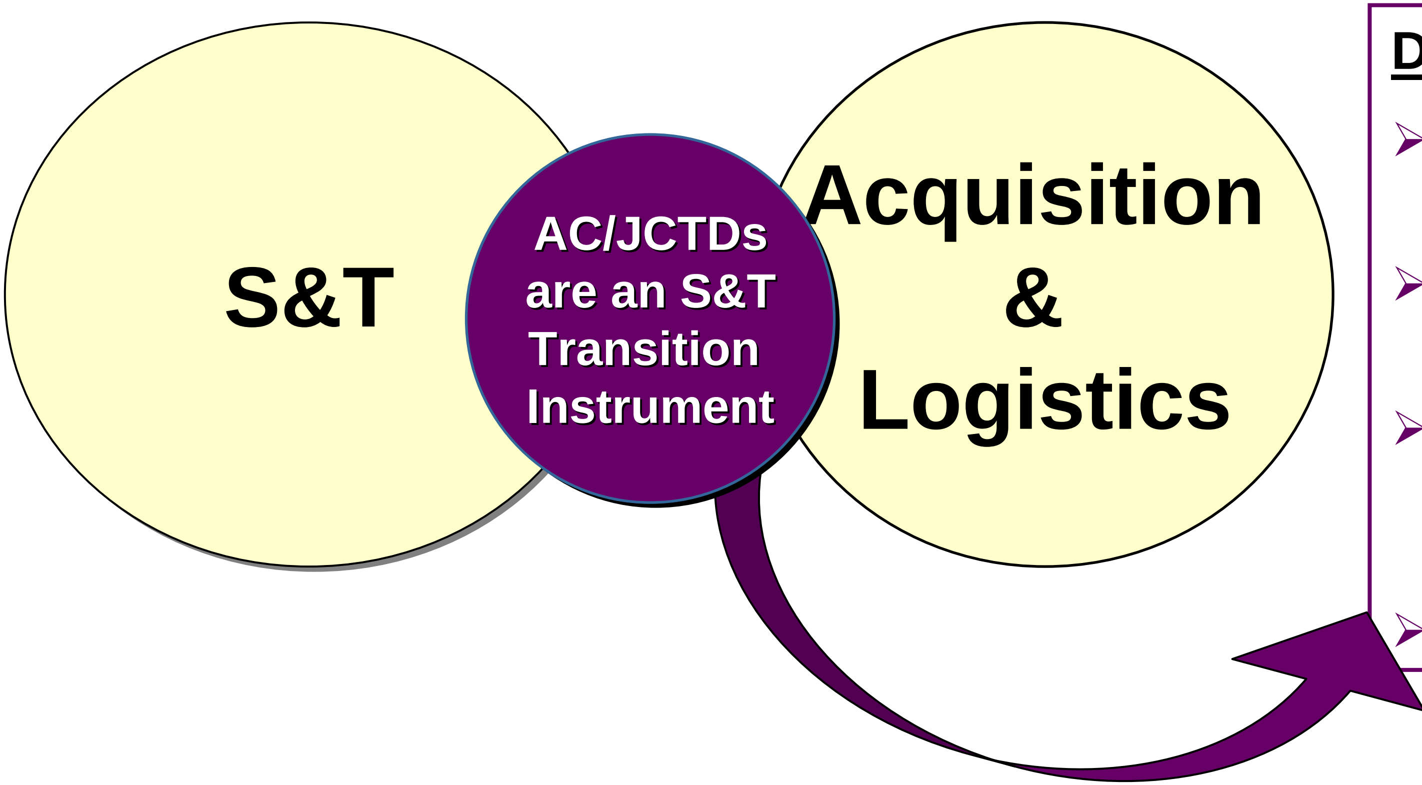
OSD / Advanced Systems & Concepts

- Address CoCom needs with ***Mature Technology and/or an Innovative Concept***
- Provide technical solution with ***Operational Concepts and TTPs***
- Evaluate solutions in warfighter ***Operational Demonstrations***
- Usually ***Joint***, often ***Combined/Coalition/Interagency***
- ***Rapid Results***: ***1 to 3 Years or less*** to Final Demonstration and a ***Prototype "Leave-Behind"***
- ***Multiple Funding*** sources with a ***Transition Agreement***

Emphasis on demonstration and transition…try with intent to buy

AC/JCTDs Bridge S&T and Acquisition

Filling the Gap between S&T and Acquisition for COCOM Customers - Providing Relevant/Urgent Tools to Joint and Coalition Warfighters



Deliverables:

- Concept of Operations
- Military Utility Assessment
- Residual Capability "leave behind"
- Business Case

AC/JCTDs are <u>not</u> acquisition programs; they demonstrate new capabilities

Completed ACTDs Deployed in Recent Conflicts*

OSD/Advanced Systems & Concepts

Adaptive Course of Action
Advanced Joint Planning
Airbase/Port Biological Detection
Area Cruise Missile Defense
Battlefield Awareness & Data Dissemination
Chemical Add-On to Biological Detection
Coastal Area Protection
Coherent Analytical Computing Environment
Common Spectral MASINT Exploitation
Consequence Management
Counterproliferation I
Counterproliferation II
Counter Sniper
C41 for Coalition Warfare
Extending Littoral Battlespace/JTF WARNET
Global Monitoring of Space ISR Systems
High Altitude Endurance UAV – Global Hawk
Human Intel & Counterintelligence Tool
Info Assurance: Auto Intrusion Det Envir
Integrated Collection Management
Joint Biological Remote Early Warning
Joint Combat Identification
Joint Logistics
Joint Medical Operations/Telemedicine
Link-16
Medium Altitude Endurance UAV – Predator
Military Ops in Urban Terrain
Navigation Warfare
Precision/Rapid Counter-MRL
Personnel Recovery Mission Software
Precision SIGINT Targeting
Precision Targeting Identification
Rapid Force Protection Initiative
Small Unit Logistics
Space Based Space Surveillance Operations
Theater Air & Missile Defense Interoperability
Theater Precision Strike Operations
Unattended Ground Sensors

**Recent conflicts include: Operation Allied Force (Kosovo), Operation Enduring Freedom (Afghanistan), Operation Iraqi Freedom (Iraq), Noble Eagle (US Air Space), and Other (support to USFK, Space Shuttle Columbia recovery operation, and US Olympics)*

Active ACTDs Deployed in Recent Conflicts*

Active Network Intrusion Defense
Adaptive Battlespace Awareness
Boundary Step
Coalition Theater Logistics
Comm/Navigation Outage Forecast System
Computerized Operational MASINT Weather
Contamination Avoid at Seaports of Debarkation
Expendable Unmanned Aerial Vehicle
Ground-to-Air Passive Surveillance
Homeland Security Command & Control
Joint Adv Health & Usage Monitoring System
Joint Area Clearance
Joint Distance Support & Response
Joint Explosive Ordnance Disposal
Joint Intelligence, Surveillance, and Reconnaissance
Language & Speech Exploitation Resources

Overwatch
Pathfinder
Personnel Recovery Extraction Survivability
Restoration of Operations
Spartan C2 Module & CONOPS
SIGINT Processing
Theater Support Vessel
Thermobarics

JPADS

**Recent conflicts include: Operation Allied Force (Kosovo), Operation Enduring Freedom (Afghanistan), Operation Iraqi Freedom (Iraq), Noble Eagle (US Air Space), and Other (support to USFK, Space Shuttle Columbia recovery operation, and US Olympics)*

AC/JCTD Performance Statistics

OSD / Advanced Systems & Concepts

• Total ACTDs and JCTDs Initiated	162
• Total ACTDs On Hold	3
• Total Active ACTDs/JCTDs	61
• Total ACTDs Terminated/Return to Tech Base	21
• Completed ACTDs (Demo Complete + Tech Base)	99

• **Completed ACTDs that have/are Transitioning Products (Program of Record or Residual Sustainment):**

– ACTD Products Transitioned to Program of Record	38%	80%
– ACTDs where Residuals Products are Meeting Needs	42%	
– ACTDs Returned to Technology Base	20%	

80% of <u>completed</u> ACTDs have transitioned products into new or existing PORs or as residual products to meet warfighter needs.

USPACOM/AS&C AC/JCTD Partnership

OSD / Advanced Systems & Concepts

- 14 new PACOM sponsored A/JCTDs since 2004 (27% of total)
- Started 11 of 12 A/JCTD proposals ranked by PACOM #1, 2, and 3 since 2004*
- Significant direct support to PACOM J85 and J006 for JE and A/JCTD roles
- Strong focus on USPACOM priorities, as shown below

USPACOM Focus Areas / Active USPACOM Sponsored AC/JCTDs	COSMOS	CMS	JMMES	CMA	JETA-SPOD	ASAP	CUGR	MSAT	ARGCS	FTTS	TEBO	Overwatch	MAV	JSuW*	AWSS*
Prosecute and Win the War on Terror	■		■	■		■	■	■				■	■	■	■
Advance Regional Security Cooperation and Engagement	■	■	■	■							■				■
Mature Joint and Combined Capabilities and Readiness	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Posture Forces for Agile and Responsive Employment		■			■			■	■	■					
Ensure Operational Plans Are Credible		■			■						■			■	■

* Assumes successful start of planned FY07 rolling starts

Joint Capability Technology Demonstrations
- 2007 JCTD New & Potential Rolling Starts -

OSD / Advanced Systems & Concepts

- Coalition Mobility System (CMS)
  - *Integrates data from US systems with data from coalition partners for coalition decisions.*
- IP Routing in Space (IRIS)
  - *Provides routing and dynamic bandwidth resource allocation from a commercial geo-sat.*
- Joint Multi-Mission Electro-Optic System (JMMES)
  - *Automated image processing and targeting for wide-area surveillance in a common turret.*
- Mapping the Human Terrain (MAP-HT)
  - *Data collection and visualization toolkit to support Brigade Combat Teams.*
- Maritime Domain Awareness (MASTER)
  - *Automatically generates and maintains vessel tracks by fusing all available data.*
- Smart Threads Integrated Radiological Sensors (STIRS)
  - *Detects and identifies radiological and nuclear materials using next-gen neutron detector.*
- Tactical Service Provider (TSP)
  - *Provides wideband, high-bandwidth services for tactical users using a hybrid of emerging, standards-based SATCOM and wireless technologies in a mobile tactical environment.*

- Airborne Weapons Surveillance System (AWSS)
  - *Line-of-sight detection, identification and location hostile ground fire for counter fire.*
- Global Observer (GO)
  - *Liquid hydrogen-powered UAV with affordable persistence and low footprint*
- Joint Surface Warfare (JSUW)
  - *Uses maturing weapon data link network technologies to integrate multiple ISR & launch platforms with existing stand-off weapons to provide targeting data for multiple weapons.*

Increasing Your Support to COCOMs

OSD / Advanced Systems & Concepts

AS&C Program	Actions and Outcomes
Joint Capability Technology Demonstrations	• Needs Specified • Lead Proposal Development • Operational Management • Solutions Assessed
Foreign Comparative Test	• Projects Supporting Theater Security Cooperation Strategy are Advocated
Technology Transition Initiative	• Projects Addressing Capability Gaps • Coordinate with Components

Considering Warfighter R&D Investments…

OSD / Advanced Systems & Concepts

…questions should be answered affirmatively:

1. Does the action address the COCOM's needs*?
2. Is a significant Joint capability or military advantage gained?
3. Do we have a clearly stated and attainable goal/outcome?
4. Have risks and costs been fully and frankly analyzed?
5. Have all other DOTMLPF** means been fully explored?
6. Is there an exit strategy to avoid endless development?
7. Have consequences of inaction been fully considered?
8. Can support be garnered from the Services and Congress?
9. Are experienced people available to execute the effort?
10. Can results be demonstrated to project champions (<PCS)?

---

* Integrated Priority Lists and Most Pressing Military Issues – as validated by JCS J8
** DOTMLPF: Doctrine, Organization, Training, Materiel, Leadership, Personnel and Facilities

Criteria proposed by John Kubricky for selecting project candidates to support CoCom needs.

Joint Staff - Most Pressing Military Issues

- Collect and fuse multi-source sensor data increasing situational understanding
- Provide persistent surveillance in ungoverned/denied areas
- Using Department/Interagency capabilities, develop shaping strategies to assist nations at strategic crossroads
- Improve information sharing to support operational forces and mission partners by providing adequate bandwidth and information sharing tools, as well as appropriate information sharing policies.
- Improve joint force management; joint force projection and joint force sustainment
- Establish capability to locate, tag, and track individuals and loose WMD (securing and rendering safe)
- Integrate defenses for cruise and ballistic missiles
- Improve skills and capacity to detect and prevent state and non-state actors from acquiring and using WMD
- Define and develop strategic communications concepts
- Increase and improve irregular warfare capacity in conventional forces (language, cultural, behavioral, HUMINT) and ability to model irregular challenges
- Improve C2 for joint ops in distributed environment that facilitates joint interdependence
- Insert Spec Ops into denied areas
- Improve capacity to protect critical infrastructure

Reducing Risks after Capability Demonstration

OSD / Advanced Systems & Concepts

Manufacturing Readiness Levels

5000: Pre-Concept | Concept Refinement (Concept Decision) | **A** | Technology Development (Component, System) | **B** | System Development and Demonstration (Design Readiness Review) | **C** | Production and Deployment (FRP Decision Review) | Ops & Support

TRL – Technology Readiness Levels: TRL 4 | TRL 5 | TRL 6 | TRL 7 | TRL 8 | TRL 9

MRL – Manufacturing Readiness Levels

	MRL 1–3	MRL 4	MRL 5	MRL 6	MRL 7	MRL 8	MRL 9	MRL 10
MRL	1 · 2 · 3	MRL 4 Lab or Modeling Environment	MRL 5 Prototypical Environment	MRL 6 Pre-production Representative Environment	MRL 7 Transition into LRIP	MRL 8 Low Rate Initial Production	MRL 9 Full Rate Production	MRL 10 Lean Production
Considerations	Manufacturing Concepts Identified	Mfg. Processes Identified Key Processes Identified Producibility Assessments Initiated	Mfg. Processes Developed Producibility Assessments On-going Mfg. Cost Drivers Identified	Critical Processes Demonstrated Cost Drivers Analyzed Long Lead Items Identified Equipment in a Relevant Environ	Mfg. Processes in Validation Producibility Improvement Underway Trade Studies Applied Supply Chain Validated	Process Maturity Demonstrated All Materials Ready for LRIP Mfg. Processes Proven Supply Chain Established	Mfg. Processes Operating at Target Quality, Cost and Performance Supply Chain Stabilized to Meet Production Lead Time Requirements	Lean/Six Sigma Production in Place Meeting or Exceeding Cost, Schedule and Performance Goals
Exit Criteria	✓ Meeting TRL 1 – 3 ✓ Identify Industrial Base (IB) Sources ✓ Characterize Basic Materials for Mfg. ✓ Identify Material Concerns ✓ Identify Funding ✓ Identify Advanced ManTech Initiatives ✓ Coordinate with Technology Plan	✓ Meeting TRL 4 ✓ Identify IB Gaps ✓ Assess Design for X ✓ Baseline Materials and Issues ✓ Funding/Budgeting for Trade Studies ✓ Identify ManTech or Other Initiatives ✓ Quality Strategy ✓ Mfg. Strategy ✓ Material and Tooling Planning	✓ Meeting TRL 5 ✓ IB Analysis Finished ✓ KPPs Allocated ✓ Material Development Begun ✓ Funding to Meet Next Level ✓ ManTech Initiatives Initiated ✓ Key Characteristics Identified ✓ Make/Buy Evaluations Begun	✓ Meeting TRL 6 ✓ IB Capability Est. ✓ Initial Trade Studies ✓ Materials Matured on Similar Lines ✓ Funding to Meet Next Level ✓ ManTech Solutions Developed ✓ Quality Thresholds Established ✓ Make/Buy Evaluations Done	✓ Meeting TRL 7 ✓ IB Monitored ✓ PEP Completed ✓ Materials Being Proven ✓ Funding to Meet Next Level ✓ ManTech Solutions Demonstrated ✓ Collecting Quality Data ✓ BOM Suppliers Identified	✓ Meeting TRL 8 ✓ Multiple Sources Established ✓ Pilot Line Builds Validated ✓ Materials Proven ✓ Funding to Meet Next Level ✓ ManTech Solutions Applied/Validated ✓ Validated Quality Characteristics ✓ BOM Supports LRIP	✓ Meeting TRL 9 ✓ IB Supports Sched ✓ Continuous Process Improvement is Ongoing ✓ Materials in Control ✓ Funding to Meet Next Level ✓ Quality Validated with LRIP Articles ✓ Make/Buy Supports FRP	✓ Meeting TRL 9 ✓ Monitor and Manage ✓ Key Characteristics at Six Sigma Level ✓ Funding Meets Six Sigma Goals ✓ No Changes to Make/Buy Decision ✓ All Key Suppliers Meet Six Sigma Goals

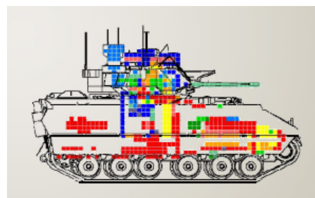
Discussion

AS&C	www.acq.osd.mil/asc	**703-695-5036**
AC/JCTD	www.acq.osd.mil/actd	**703-697-5558**
Comparative Test Office (FCTs)	www.acq.osd.mil/cto	**703-602-3740**
Office of Technology Transition	www.acq.osd.mil/ott/tti	**703-607-5316**
Joint & Coalition Operations Support	**(under construction)**	**703-693-0462**

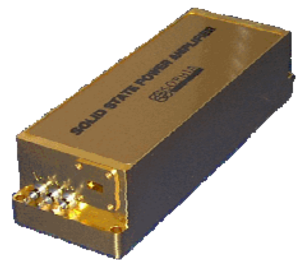

U.S. Army Research Laboratory
ARL
TECHNOLOGY TO WIN
John M. Miller
Director
FCS Technology Insertion
and Transition Panel
2006 Research Laboratory of the Year
U46

Army Research Laboratory Support to Future Combat Systems

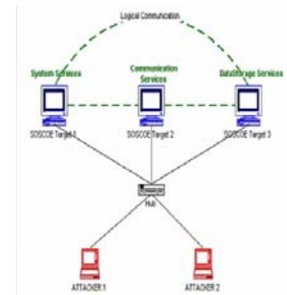
Crew Station Design



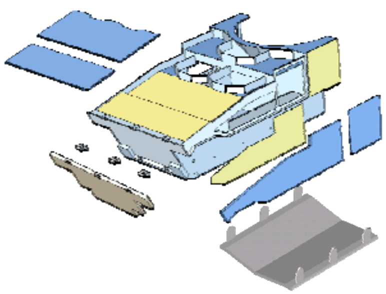
SLA Vehicle Design Support



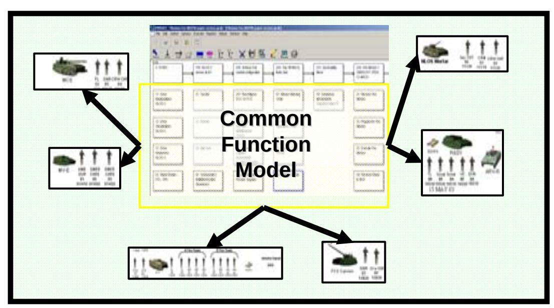
Solid-State Power Amplifier



SOSCOE Information Warfare Analyses



Armor Technologies



Soldier Performance Prediction

Tactical Wireless Network Assurance

Solid-State Power Amplifier (SSPA) for FCS SATCOM OTM (Vertex RSI system)

Purpose:

Create an SSPA "TWT replacement" for Army communications and sensor applications with:

- ***Low cost, compact form factor, designed for manufacturability***
- ***Increased ruggedness and power efficiency***
- ***Modular architecture for rapid response to changing frequency and power requirements***

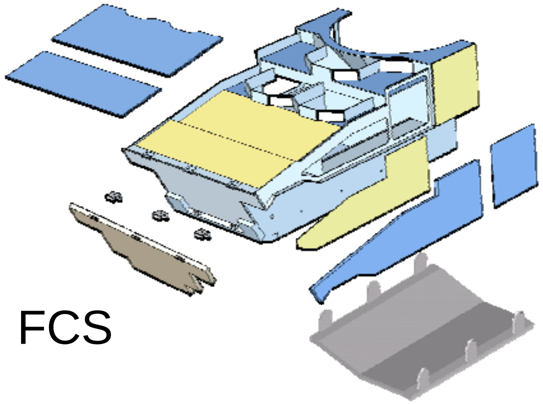
Approach:

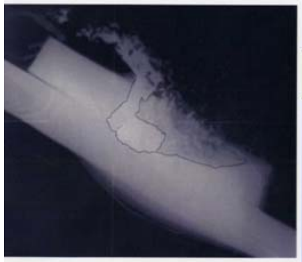
Coherent operation of up to eight commercial off-the-shelf (COTS) millimeter-wave integrated circuit (MMIC) amplifiers in a broadband, extremely low-loss waveguide combiner

Payoff:

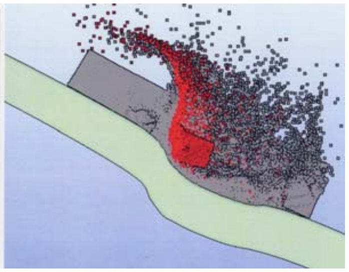
- ***2005 Army SBIR/STTR Phase II Quality Award***
- ***Rugged, reliable Ka band power amplifier for warfighter satellite communications***
- ***Selected by General Dynamics for insertion into FCS SATCOM OTM earth station (Vertex RSI system)***

Armor Technologies





1 MeV X-Rays of Ballistic Experiments



Corresponding Numerical Simulations

Purpose:

- *In partnership with TARDEC, develop lightweight armor technologies and validate models for use by FCS to defeat Medium Caliber Automatic Cannon, Heavy Machine Gun (HMG), Artillery Fragments, IEDs, RPGs and bomblets*
- *Provide design guidance and protection strategies for mine blast protection*

Approach:

- *Couple advanced materials & lightweight structures with penetrator defeat mechanisms*
- *Validate weight and space efficient multi-functional armor technologies*
- *Develop statistically rigorous data to support models and design guidance*

Payoff:

- *Improved mobility and crew survivability for FCS vehicles at a reduced weight*
- *Transition to TARDEC for FCS and Current/Future Force tactical and logistic vehicles*

Tactical Wireless Network Assurance

Purpose:

In partnership with CERDEC, develop algorithms for wireless network protection solutions for tactical Mobile Ad-hoc Networks (MANETs)

Approach:

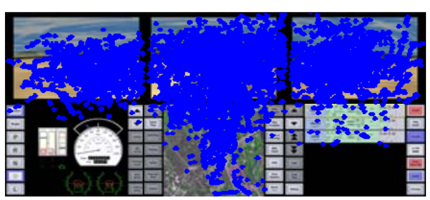
- ***Algorithm development for detection of attacks on MANET routing involving multiple attackers***
- ***Specialized clustering algorithms to create and maintain a dynamic hierarchy of intrusion detection components***
- ***Analysis and assessment of intrusion detection algorithms to realistically emulate tactical MANETs***

Payoff:

- ***Protect tactical MANETs from attacks***
- ***Maintain Warfighter trust/confidence in battlefield information***
- ***Reduce system and network vulnerabilities***
- ***Enhance wireless network availability***
- ***Transition through CERDEC to FCS***

Crew Station Design Needs for FCS Manned Ground Vehicles (MGV)

Sample Subject Eye-tracking Indirect Vision Driving (Pilot)



Sample Subject Eye-tracking Autonomous (Pilot)

Purpose:

In partnership with TARDEC, determine MGV crew station design and robotic interface needs

Approach:

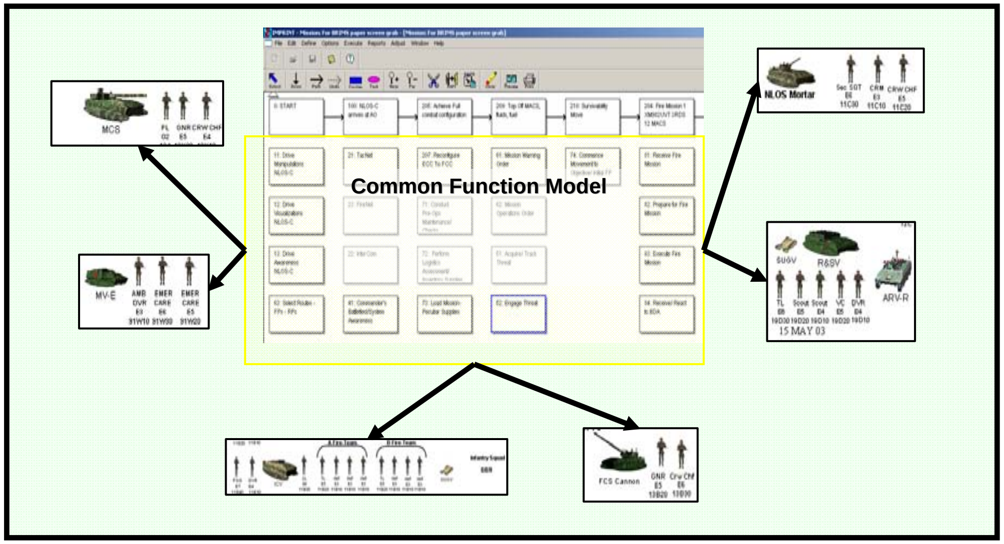
- ***Quantify Soldier attention, workload, and performance through experimentation***
- ***Optimize crew tasking through selective application of autonomous mobility technologies***
- ***Develop embedded Soldier monitoring and evaluation capabilities in moving vehicles***
- ***Evaluate specialized interface techniques for enhanced Soldier performance with robotic systems***

Payoff:

Transitions to FCS crew station efforts:

- ***Indirect vision drive by wire systems designs***
- ***Specialized operator control unit techniques***
- ***Design guidelines for scalable robotic interfaces***
- ***Manual and supervisory robotic control methods***

Soldier Workload and Performance Prediction



MCS Crew Analysis

Commander - Driver and Gunner
Highest workload of all conditions

Gunner - Driver and Commander
No shooting on the move

Commander - Gunner and Driver
Best two crewmember function allocation; single vehicle commander

Commander, Driver and Gunner
Two crewmembers scanning; allows hunter-killer philosophy

IMPRINT

Purpose:

Quantify impact of crew size, function allocation, and proposed technologies on Soldier mental workload and performance

Approach:

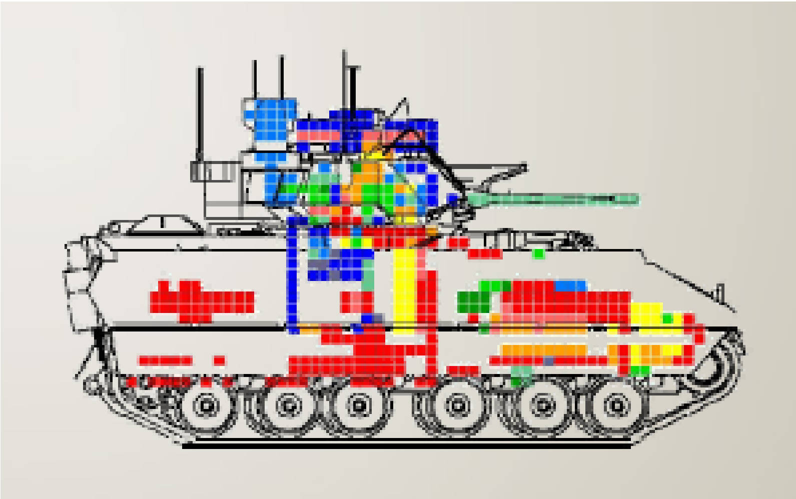
Used human performance modeling tools such as IMPRINT to identify potential high workload task combinations on a variety of FCS vehicles, e.g., Mounted Combat System (MCS), Non-Line-of-Sight Cannon (NLOS-C), and Infantry Carrier Vehicle (ICV)

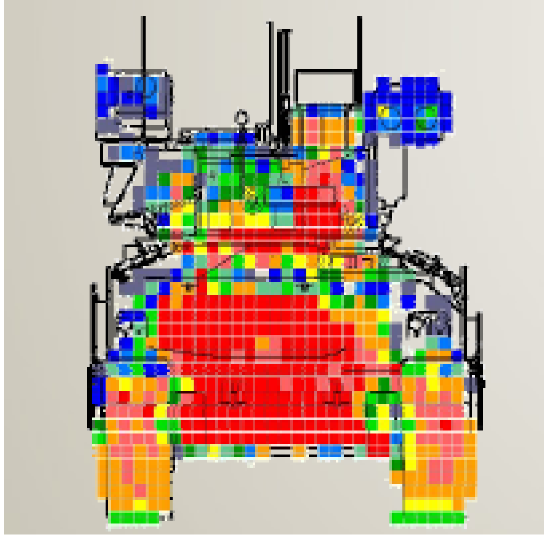
Payoff:

Refinements in the FCS ORD:

- *MCS Crew changed from 2 to 3*
- *Request automated rearming of the NLOS-C*
- *"Hunter-Killer" requirements included for the MCS and ICV*

SLA Vehicle Design Support





Purpose:

Collaborate with FCS platform vehicle integrators to:

- *Accomplish the Survivability Key Performance Parameters in balance with other design criteria such as weight, cost, performance, and reliability*
- *Decrease system and crew vulnerability by leveraging other proven vulnerability reduction techniques*
- *Increase crew survivability by using anti-fratricide and compartmental techniques on stowed munitions*

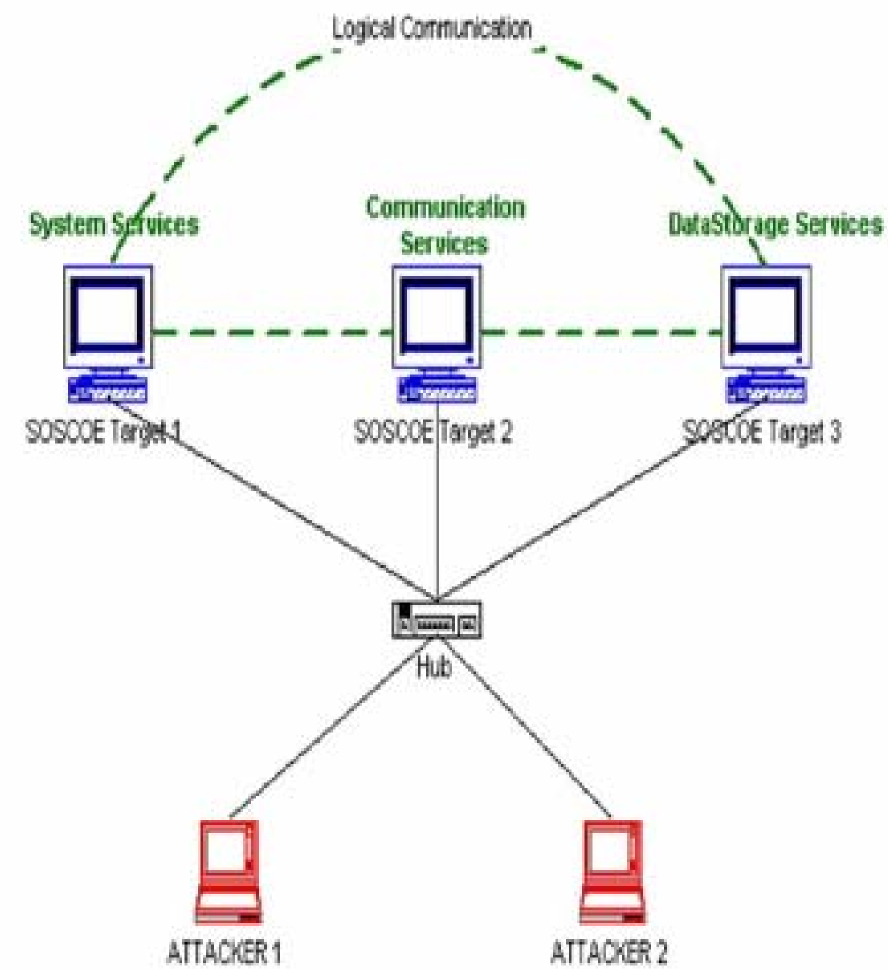
Approach:

Perform qualitative and quantitative analyses to identify potential vulnerabilities and recommend mitigation techniques.

Payoff:

- *Increased platform survivability at greatly reduced cost over the development cycle of the system*
- *Transitions to FCS for Spin Out Insertions:*
  - *Advanced armors*
  - *Active protection*

System of Systems Common Operating Environment (SOSCOE) Information Warfare Analysis



Purpose:

Perform IW analyses of SOSCOE, its Intrusion Detection System and other systems.

- *Determine IW vulnerabilities of SOSCOE 1.5.X*
- *Identify IA shortfalls*
- *Ensure IA measures are implemented in layers*

Approach:

- *Invoke IW threats against SOSCOE services and determine impact to communications between services. Use friendly (compliance) and hostile (penetration) assessment techniques*
- *Perform analytical study for conceptual solutions*

Payoff:

- *Identify IW shortcomings and mitigation techniques to enhance FCS survivability*
- *Provide input to FCS program for use in future SOSCOE builds, particularly 1.8.X and 2.0.X, which will be used in upcoming Spin Out activities*

Reducing Technology Risk in Acquisition Programs

John J. Young Jr.

Director, Defense Research and Engineering

If a great technology is developed in the lab but no one uses it, does it make a difference ….

DoD S&T Has Developed Technologies That Changed Warfighting

- **Disruptive technologies resulting from technology push:**
  - **Internet**
  - **GPS**
  - **Night vision**
  - **Lasers**
  - **Stealth**
  - **Predator**
  - **Global Hawk**

All provided dominant capability

- ***<u>None of these emerged from requirements</u>***

Stealth

UAVs

GPS

Advanced Optics and Lasers

Night Vision

Yesterday's Investment in S&T Provided Today's Capability Advantage

The Power of Long-Term Technology Development

Accuracy

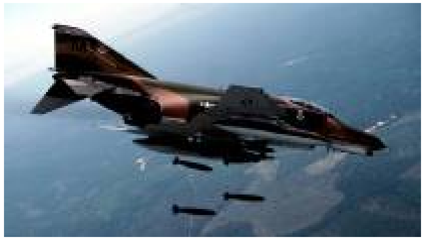
1943

1500 B-17 sorties

9000 bombs (250#)

3300 ft CEP
One 60’ x 100’ target
W.W.II

1970



30 F-4 sorties

176 bombs (500#)

400 ft CEP
One Target
Vietnam

1991

1 F-117 sortie

2 bombs (2000#)

10 ft CEP
Two Targets per Sortie
Desert Storm

1999

1 B-2 sortie

16 bombs (2000#)

20 ft CEP
16 Targets per Pass
All Weather

Accuracy

Revolutionary Technologies
Laser Guidance
GPS Guidance

DDR&E Vision

VISION: To develop technology to defeat any adversary on any battlefield

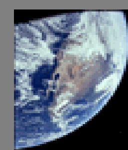
Any Battlefield includes physical, cyber, space, undersea, etc

Any Adversary includes both State and non-State actors

The Pyramid of Strategic Capability

Strategic Interests

• *Quadrennial Defense Review Driven Shift in Emphasis for Technology Program*



Defeat Any Adversary on Any Battlefield

II. Strategic Resilience

• *Enhance Linkage Technologist to Acquisition*
• *Enhance Prototypes*
• *Quick Reaction Programs*

III. Strategic Awareness

• *Global Technology Awareness*

Technology Trends and Issues

- Rate of Technology Change is Increasing
- World Becoming Technologically Smarter
- Availability of Global Commercial Technology Increasing; Need to use to Maximum Extent Possible
- Enhanced Use of Prototypes
- New Capability Needs

Multiple Dimensions Mean Multiple Solutions Needed

The Pace of Technology Development

"Moore's Law" → Computing doubles every 18 months

"Fiber Law" → Communication capacity doubles every 9 months

"Storage Law" → Storage doubles every 12 months

Defense Acquisition Pace

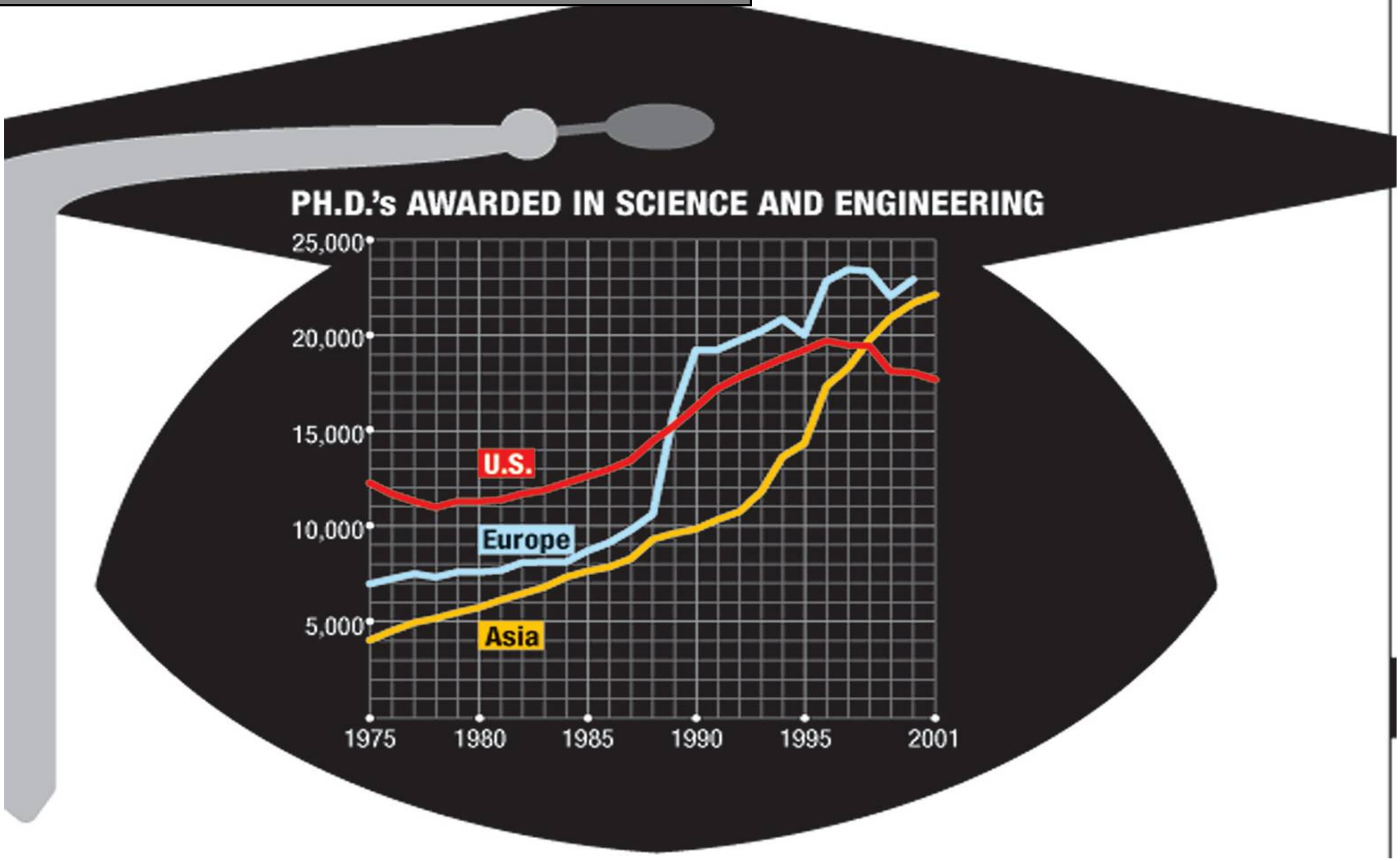
F-22	Milestone I:	Oct 86	IOC:	Dec 05*
Comanche	Milestone I:	Jun 89	IOC:	Sep 09

* Computers at IOC are 2,000 X faster, hold 130,000 X bits of information than they did at MS I

Technology growth is non-linear…
Acquisition path has been linear

Comparison of Scientists & Engineers Produced

The World is Getting Smarter

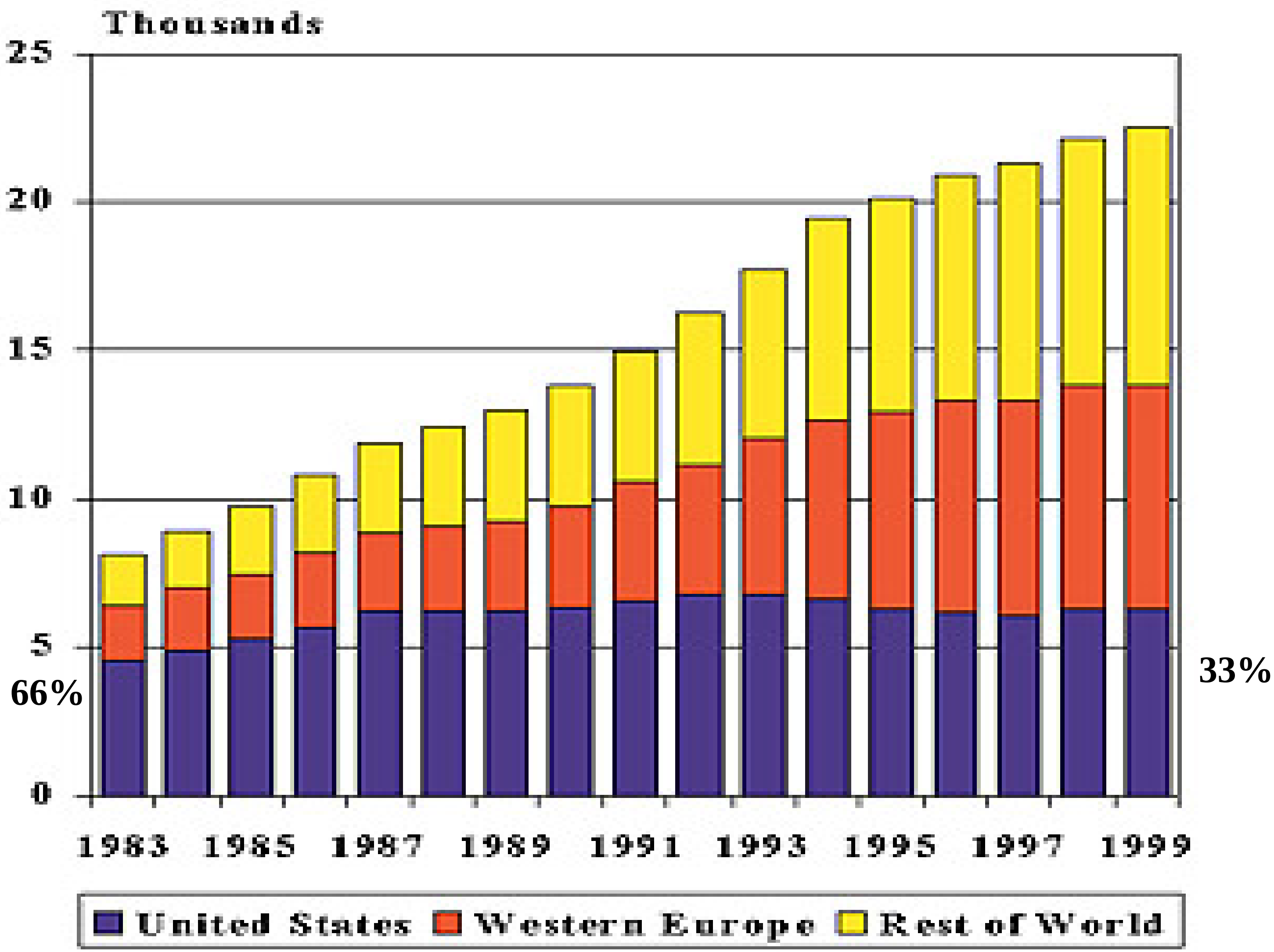


Source: Money Magazine

U.S. No Longer Leads the World in the Generation of New Scientific Knowledge

The Warning

Physical Review & Submission of Technical Papers



Source: American Physical Society - ***APS News August/September 2000***

International S&T Trends

- International Science and Technology
- Globalization
- Intellectual Capital Advantage of the US
- Pace of Technology Development
- Disruptive Technology

Net Equation—Uncertainty Increasing

Intellectual Advantage of US Waning

S&T Program Should Offer New Opportunities

The Beginning of Change

- **US National Security Strategy (March 2006) set national imperative to continue the war on terrorism**
- **2006 Quadrennial Defense Review also restated the need for DoD to balance its capabilities across four categories of challenges:**
  - Traditional
  - Irregular
  - Catastrophic
  - Disruptive

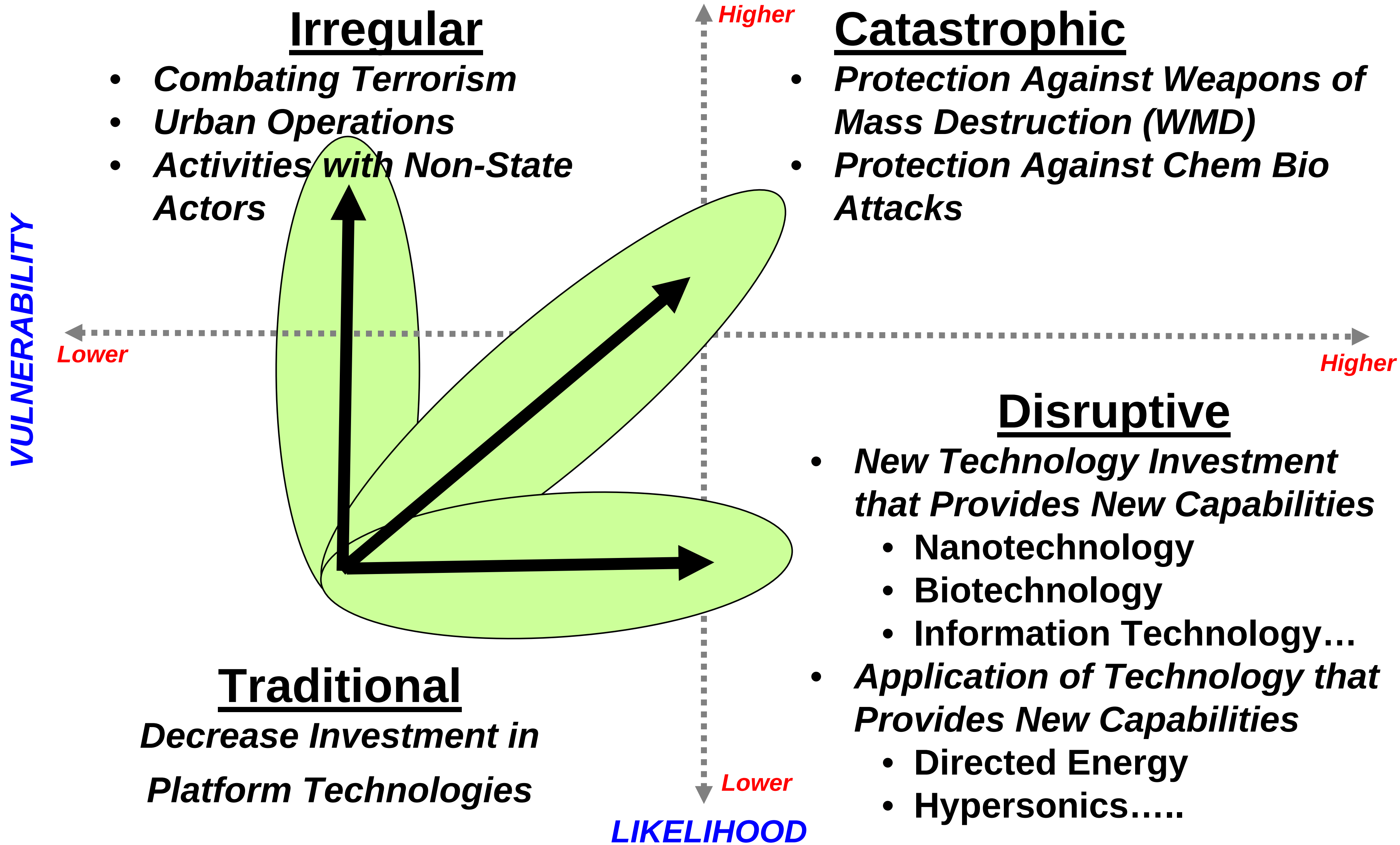
National Defense Strategy Drives Investment Strategy

Irregular

- *Combating Terrorism*
- *Urban Operations*
- *Activities with Non-State Actors*

Catastrophic

- *Protection Against Weapons of Mass Destruction (WMD)*
- *Protection Against Chem Bio Attacks*



Disruptive

- *New Technology Investment that Provides New Capabilities*
  - Nanotechnology
  - Biotechnology
  - Information Technology…
- *Application of Technology that Provides New Capabilities*
  - Directed Energy
  - Hypersonics…..

Traditional

Decrease Investment in

Platform Technologies

S&T Enabling Technology Priorities
--Supporting the QDR--

- **Potential technology focus areas:**
  - **Biometrics and Biological exploitation**
  - **Information technology and applications**
  - **Persistent Surveillance Technology**
  - **Networks and Communication**
  - **Human, Social, Cultural, and Behavioral Modeling**
  - **Language**
  - **Cognitive Enhancement**
  - **Directed energy**
  - **Autonomous systems**
  - **Hyperspectral sensors**
  - **Nanotechnology**
  - **Advanced Materials**
  - **Energy and Power**
  - **Affordability**
  - **Combating Weapons of Mass Destruction Technologies**
  - **Energetic Materials**

Integrating Intelligence into S&T Planning

- **Incorporate S&T Intelligence Products into S&T Planning Process**

How do we ensure S&T intelligence information is broadly disseminated and used in S&T Planning?

Reliance 21

Revised process incorporates Intelligence analysis into S&T planning process

S&T Net Assessment Program

Comparison of US DoD capabilities with foreign technology programs (current and future)

Project DRUMBEAT

Weekly intelligence briefing forum on scientific and technical (S&T) topics.

Global Technology Development Database

Unclassified database with information on global tech development efforts; will launch in R&E Portal June 2007

S&T Program Changes for Fiscal Year 2008

- **In Response to the QDR, the S&T Program Has New Programs Planned for FY2008:**
  - **Clandestine Tagging, Tracking and Locating;**
  - **Biometrics;**
  - **Human, Cultural, Social Behavior Modeling:**
  - **Networks;**
    - **Airborne Network Gateways**
    - **Network Science**
  - **Persistent Surveillance;**
  - **Sensor Weapon Pairing**

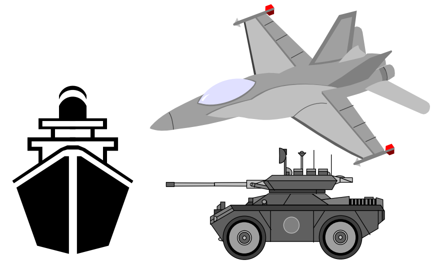
- **In Response to the Cost of Acquisition and Operations, the S&T Program Has New Programs Planned for FY2008:**
  - **Technologies to decrease energy consumption/increase alternatives**
  - **Manufacturing Technology S&T**
  - **High Performance Computational Tools for Acquisition Streamlining**

Emerging S&T Model

All Services are moving their acquisition processes

FROM

S&T



Acq

TO

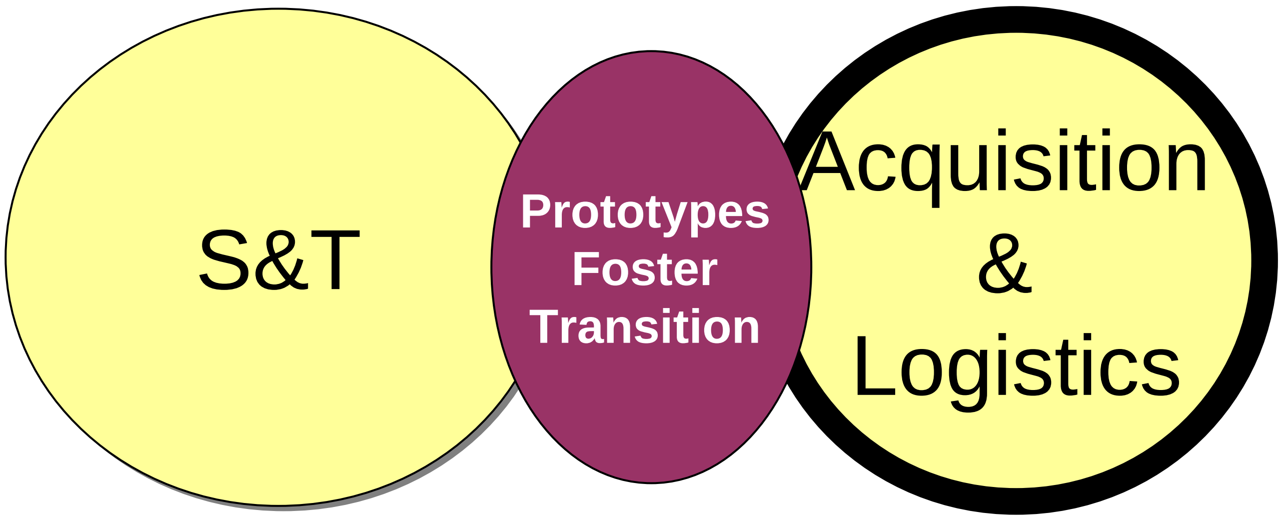
S&T

Acq

Operational
Requirements
(Warfighter)

Enhanced Linkage Leads
to
Speed and Resilience

Prototyping Pays Dividends



- *Reduces Technical Risk*
- *Reduces Cost and Shortens SDD*
- *Develops Engineering Skills*
- *Develops PM Skills*
- *Provides a Tool to Inspire Young People*
- *Attracts S&E's to Defense Challenges*
- *Allows Warfighter Familiarization*
- *Aids Requirements and ConOps*

Prototype programs are <u>not</u> acquisition programs, and should <u>not</u> be science projects

Understanding Requirements

- **Requirements do not create capability**
  - In general, requirements evolve the state of the possible
  - Requirements are best set in partnership with the warfighter, program manager, and technologist
- **Requirements do create cost**
- **Requirements are not carved in stone**
  - PMs have a right, role, and obligation to push back on requirements
  - PMs should lead the enterprise to joint, interoperable solutions

We are spending taxpayer money.
Spend it like it was your own – part of it is.

Guidelines for Program Management

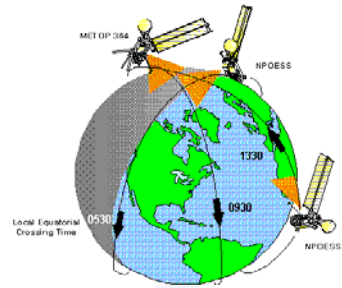
- **PMs are not victims of a process**
  - There are good reasons for an acquisition workforce and trained professionals working with accountability through the civilian chain to the President
  - PMs must lead the business to an executable enterprise solution
  - Never agree to "fix" the program in the next POM
  - Never quietly allow the enterprise to leave you with unexecutable requirements, budgets, and schedules
- **PMs are not a door-to-door salesperson**
  - Listen to new ideas, deal with them on a factual basis, and adapt when necessary
  - PMs should know their program well enough to spend tax dollars on critical path events

DoD S&T is a Partnership

Stable, Long Term Investment

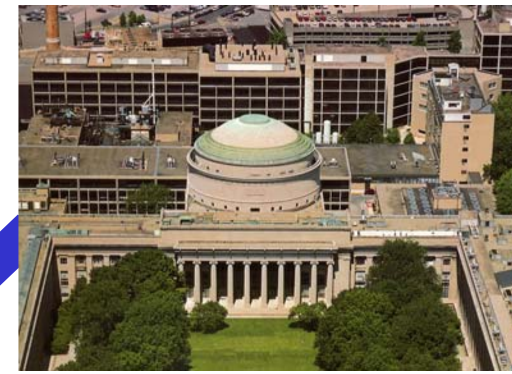
Service Labs

Expanded Resource Base



Interagency

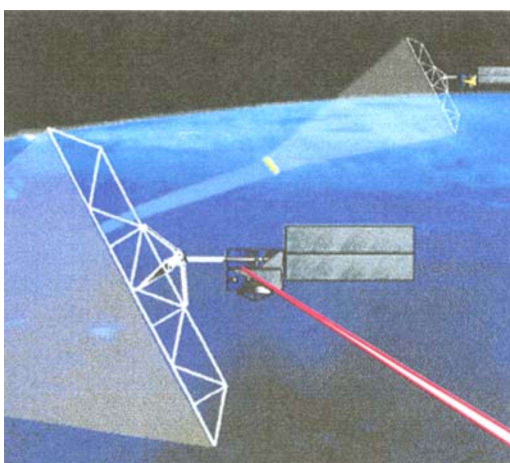
New Ideas, Knowledge



Universities

Maximum National Security Payoff

DARPA



High Risk, High Payoff

International

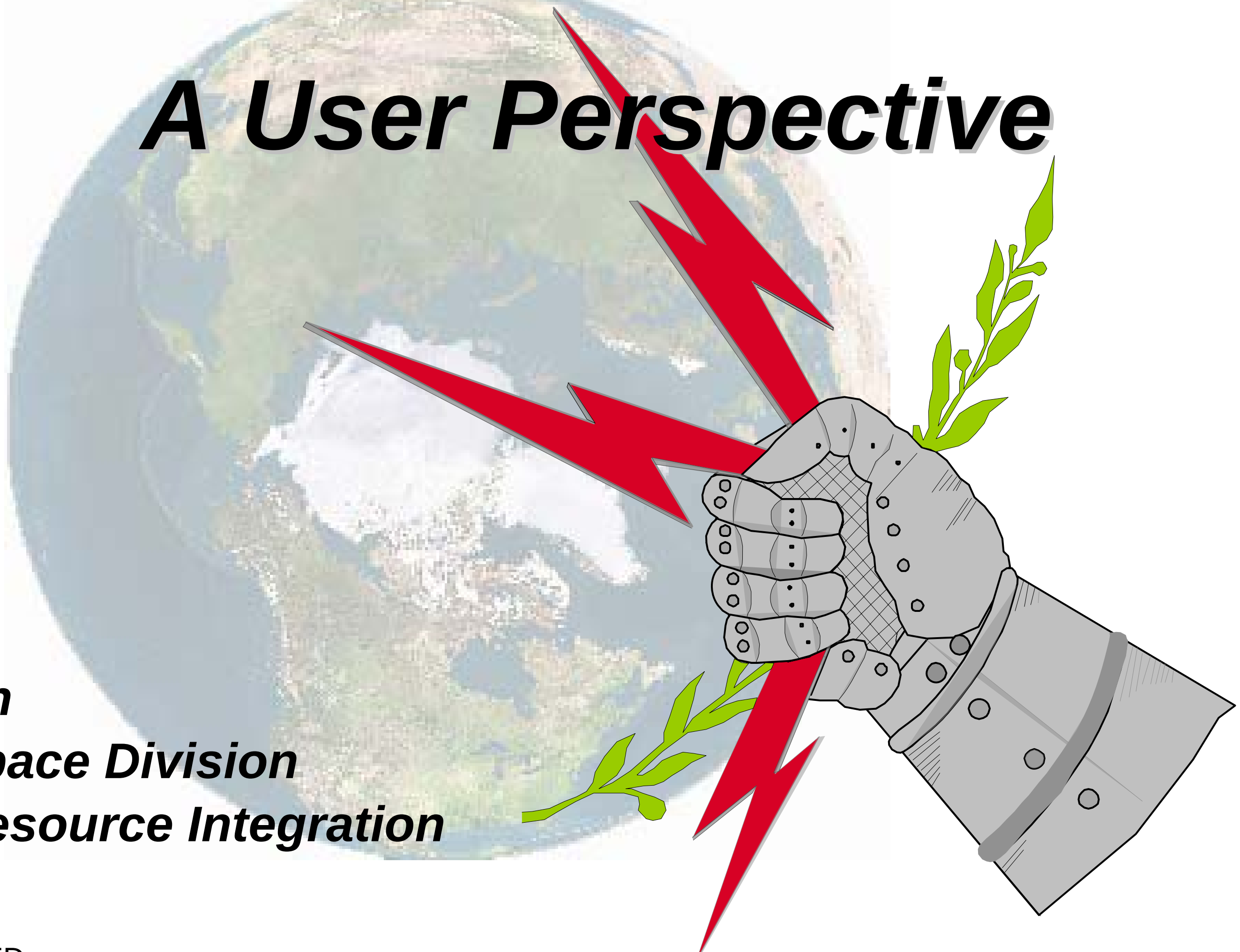
Coalition Capability

Industries

Innovation, Transition

Space Transformation Issues:

A User Perspective

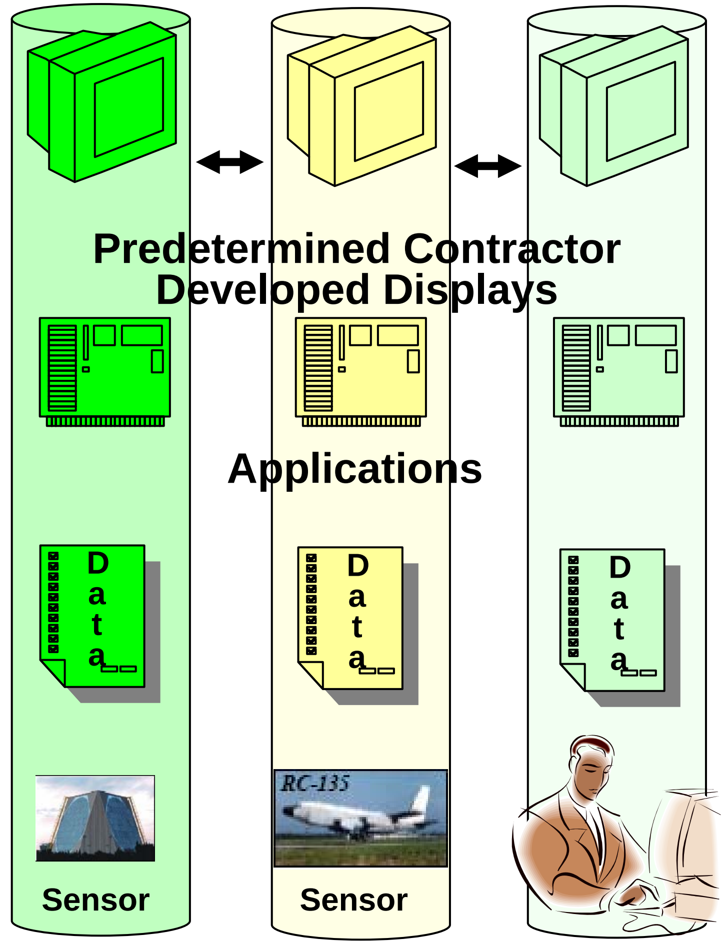


CAPT Mark Olson
Chief, ISR and Space Division
Capability and Resource Integration
17 April 07

This Briefing is UNCLASSIFIED

Space Capability Today

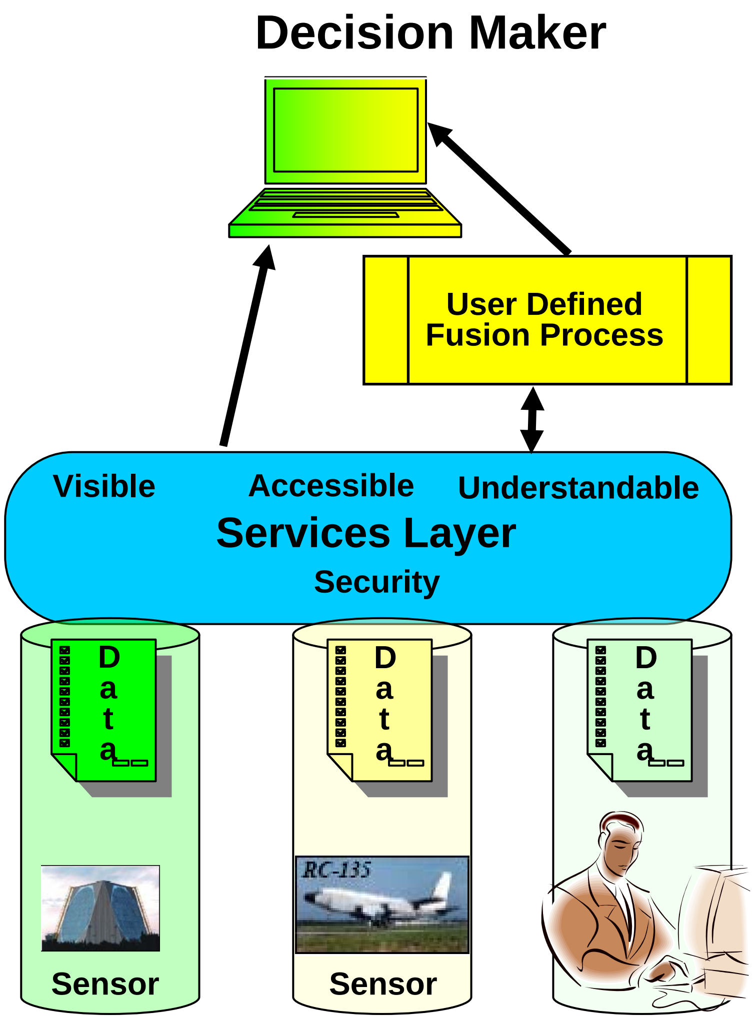
- **Space Infrastructure**
  - **Infrared Systems (e.g., SBIRS)**
  - **Environmental Sensors (e.g., DMSP)**
  - **Positional Navigation & Timing (e.g., GPS)**
  - **MILSATCOM (e.g., Milstar, DSCS, UFO)**



Great Capabilities, but…

We need a better way

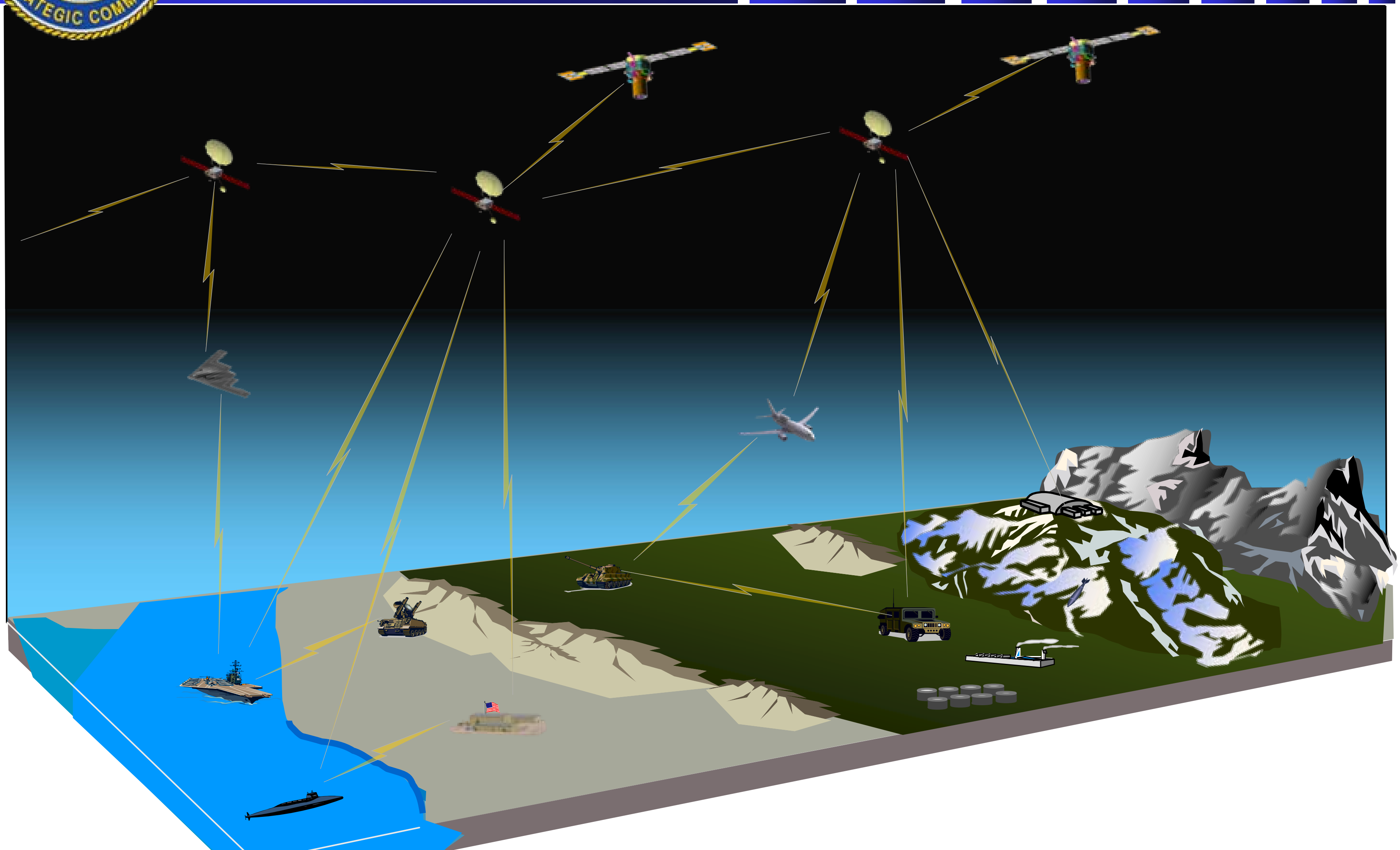
- It's all about the data!
- Users need rapid, ubiquitous access to quality* information, and be able to share knowledge…from anywhere, to anywhere



UNCLASSIFIED

*Quality Information = accurate, relevant, timely, usable, complete, brief and secure

Future Battlespace



Rapid, ubiquitous access to quality information.
Able to share knowledge…from anywhere, to anywhere.

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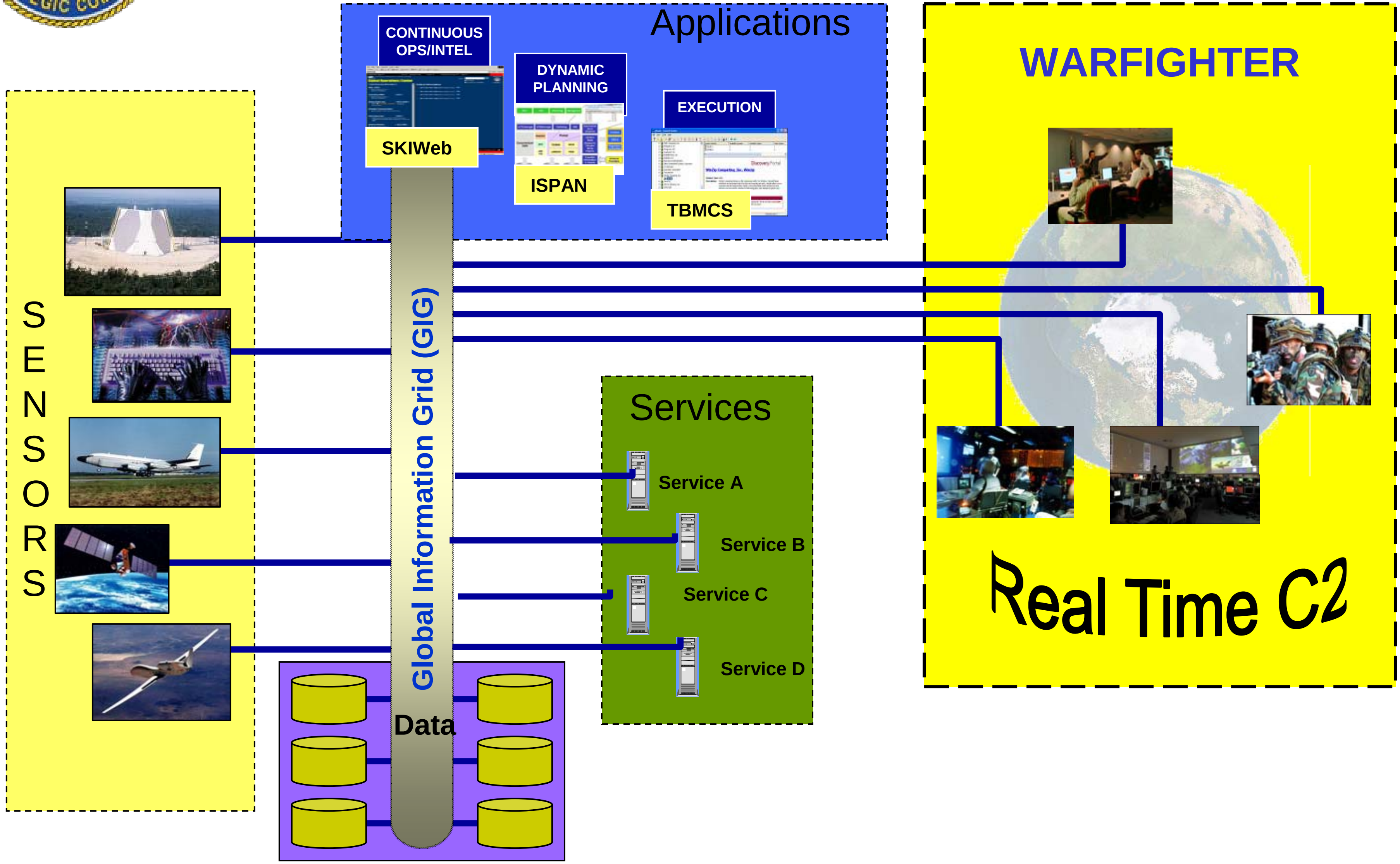
User Perspective



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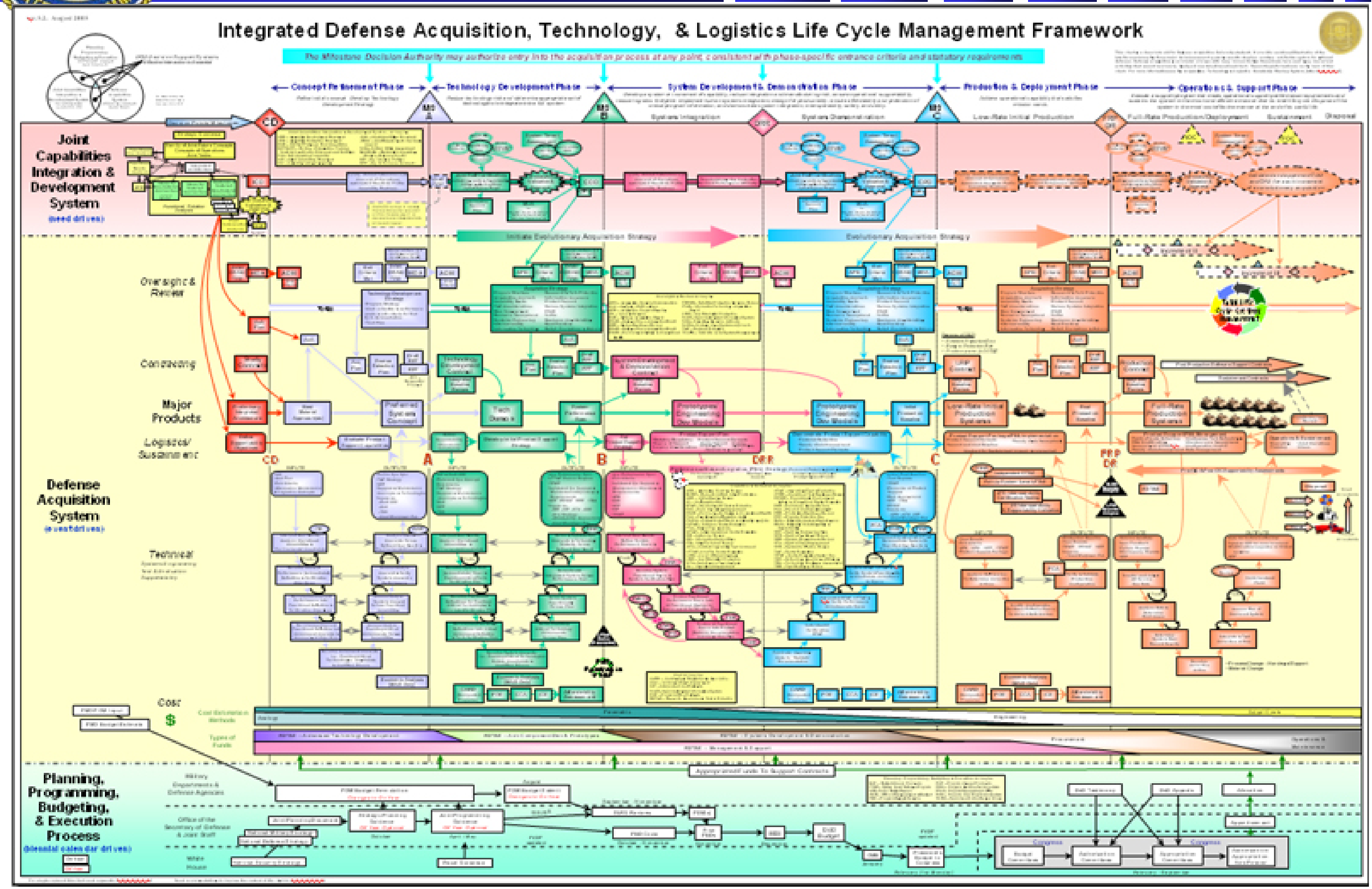
Challenges

- **Space Infrastructure**
  - **Long and complex acquisition system**
  - **Program slips/Funding cuts**
  - **Technology insertion delays**

- **Data**
  - **Access - proprietary, security, ownership, bandwidth …**
  - **Quality of service - not responsive to function**
  - **Lack adaptability - unanticipated future needs**

Is something less than 100% reliable better than nothing?

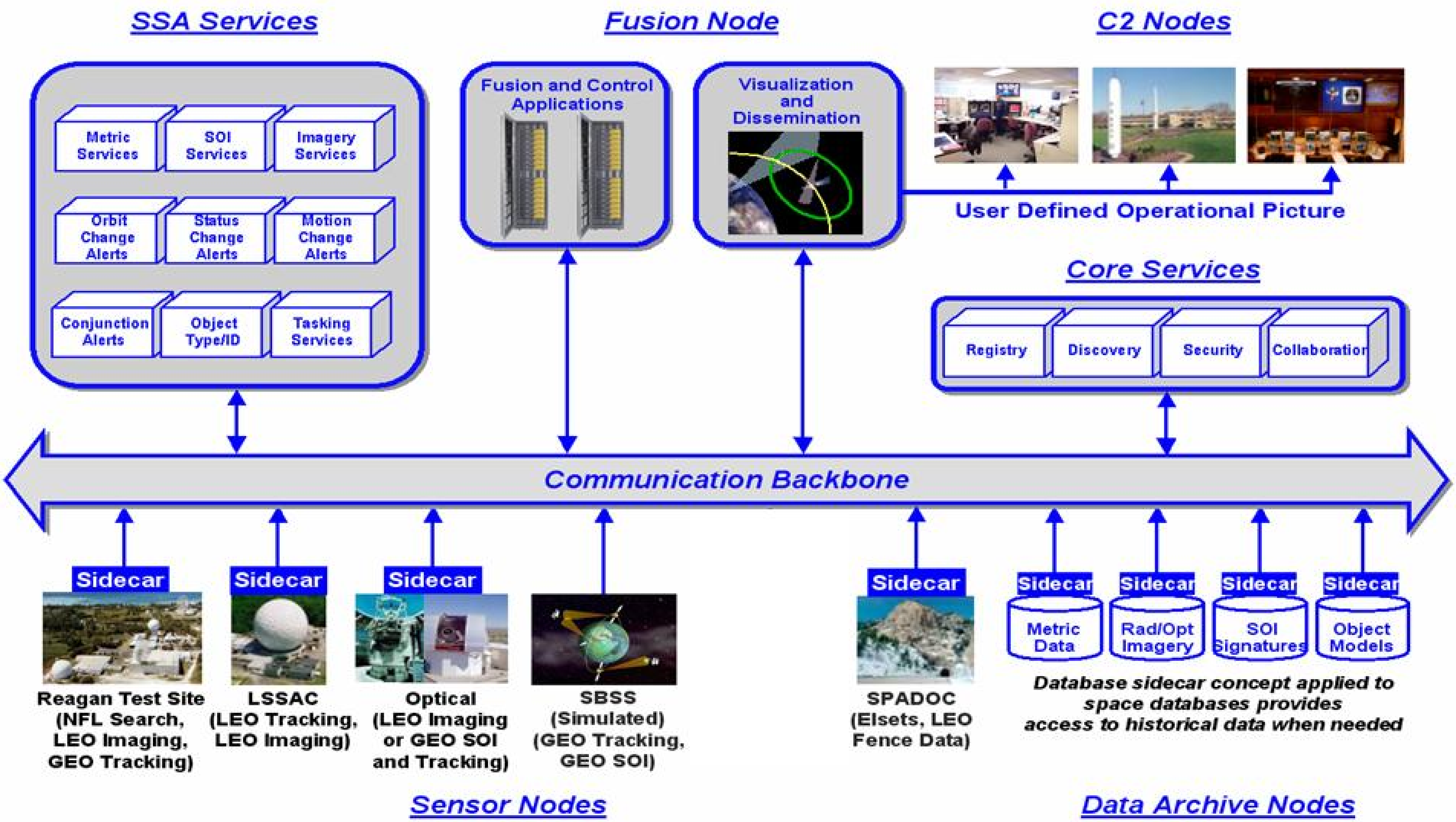
Acquisition Complexity



Response to Challenges

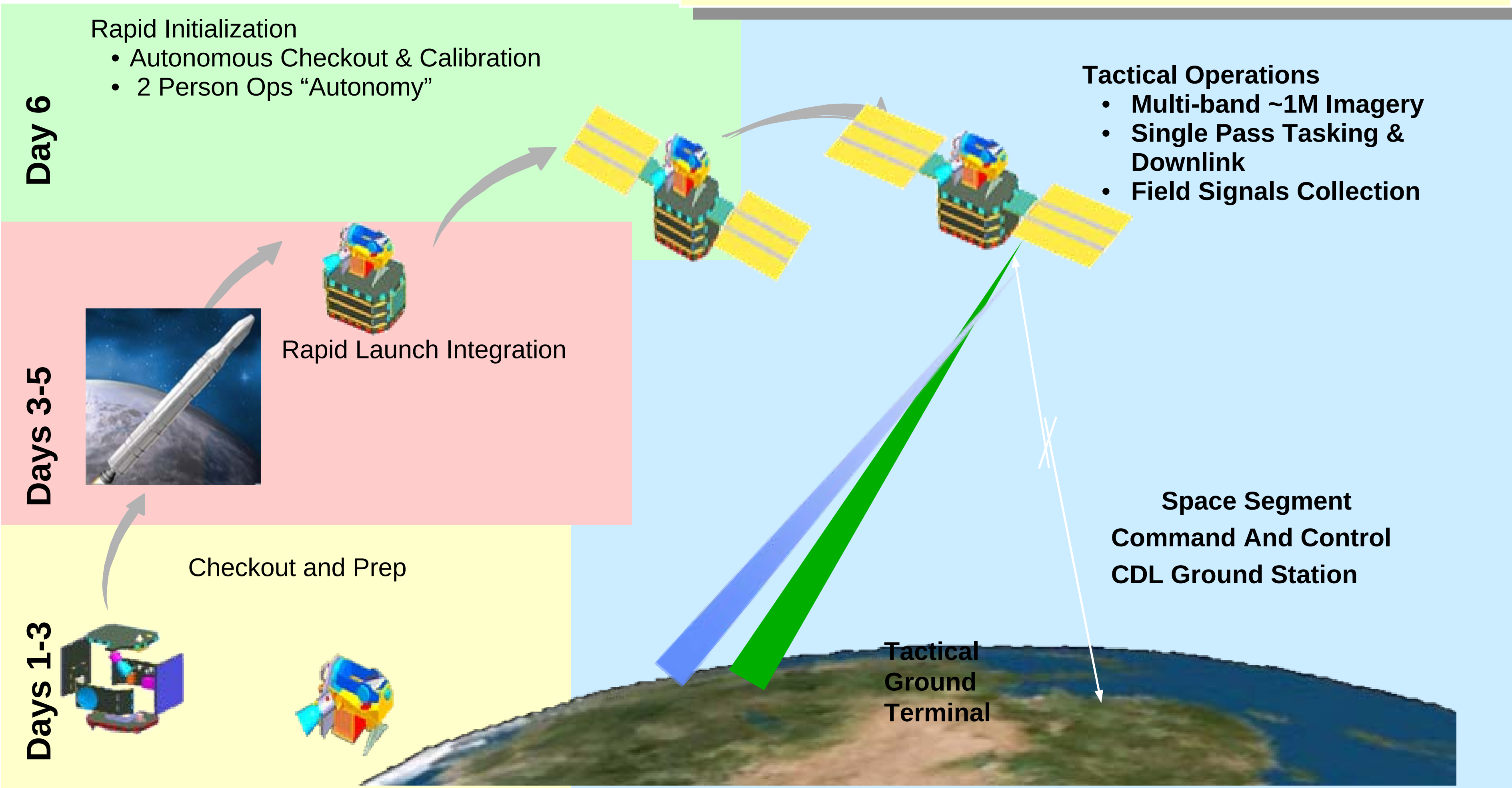
- **Joint Capability Technology Demonstrations (JCTD)**
  - **New, relevant, mature technology to warfighters quickly**
  - **Demonstration program, not a procurement program**
  - **Options that can lead to accelerated procurement**
- **JCTDs with Space Impact**
  - **Extended Space Sensors Architecture (ESSA)**
  - **Tactical Satellite-2 (TACSAT-2)**
  - **Internet Protocol Routing in Space (IRIS)**

ESSA
Extended Space Sensor Architecture



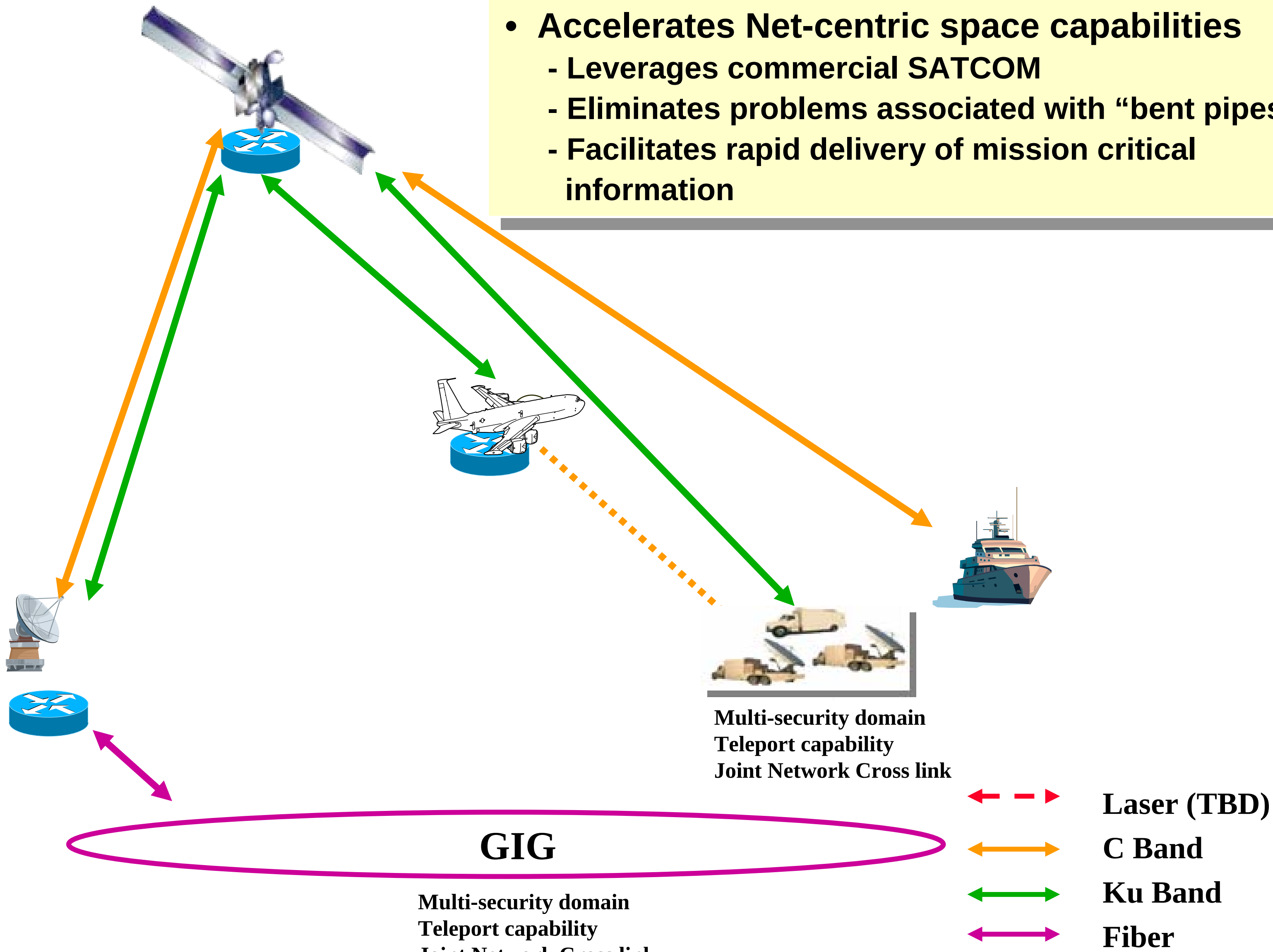
TACSAT-2
Demonstration Objectives

- **Tailored and flexible tactical satellite capability**
  - **- Responsive Space for theater Commanders**
  - **- Flexible and low cost payloads and launch**



IRIS
IP Routing in Space

- **Accelerates Net-centric space capabilities**
  - **Leverages commercial SATCOM**
  - **Eliminates problems associated with “bent pipes”**
  - **Facilitates rapid delivery of mission critical information**



Response to Challenges

Tier-1) *Command It / Employ It*

Tier-2) *Launch It / Deploy It*

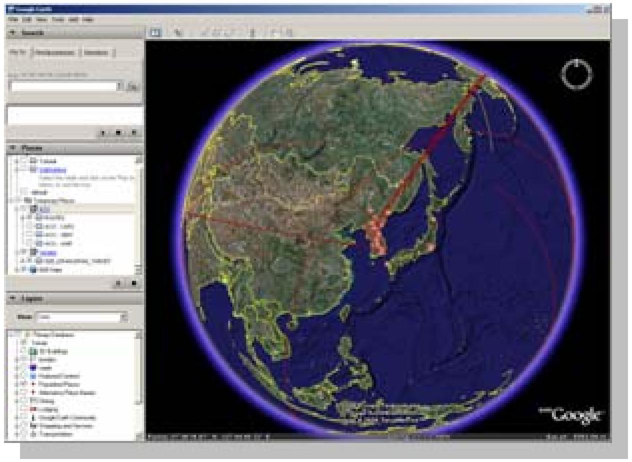
Tier-3) *Develop It*

- **Operationally Responsive Space (ORS)**
  - **Objectives**
    - **Increase responsiveness of existing space capabilities**
    - **Develop complementary, low-cost/rapid reaction capability**
  - **Focus**
    - **Meeting the JFC needs in operationally relevant timeframes**
      - **Augment on-demand capabilities optimized for JFC use**
      - **Reconstitute capabilities that fully or partially replace critical existing capabilities**
      - **Exploit existing resources to counter rapid change in national security environment**

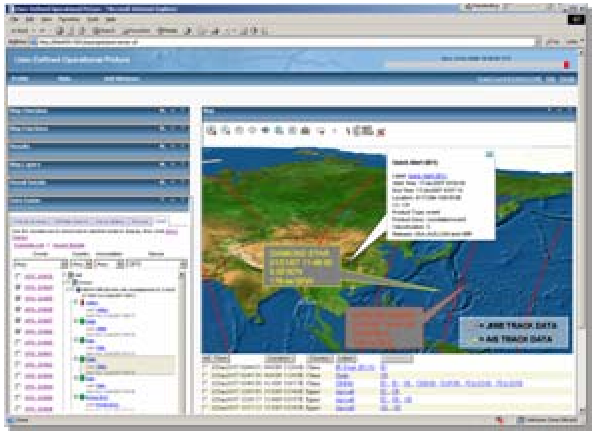
Contribute a responsive space element to joint operations

It's All About the Data …

- **Connect what's relevant, discard what's not**
  - **Ensure operational demand drives a coherent set of exposure priorities**
- **Assemble actionable information quicker than an adversary**
  - **Maximize flexibility via application of standards at the appropriate levels**
- **Think globally**
  - **Utilize an enterprise approach to issues of access, security, scalability**



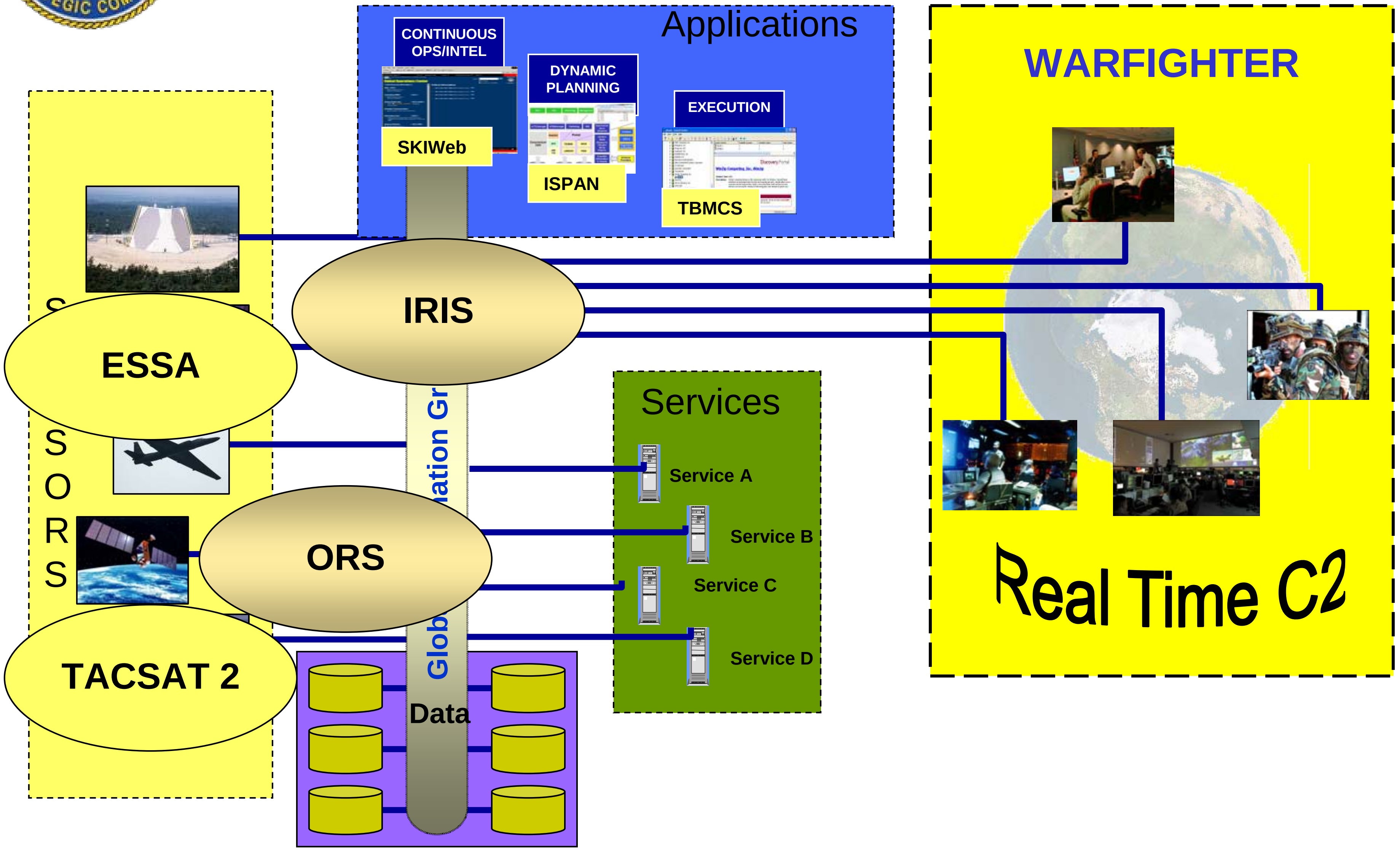
Global
(Thick Client)



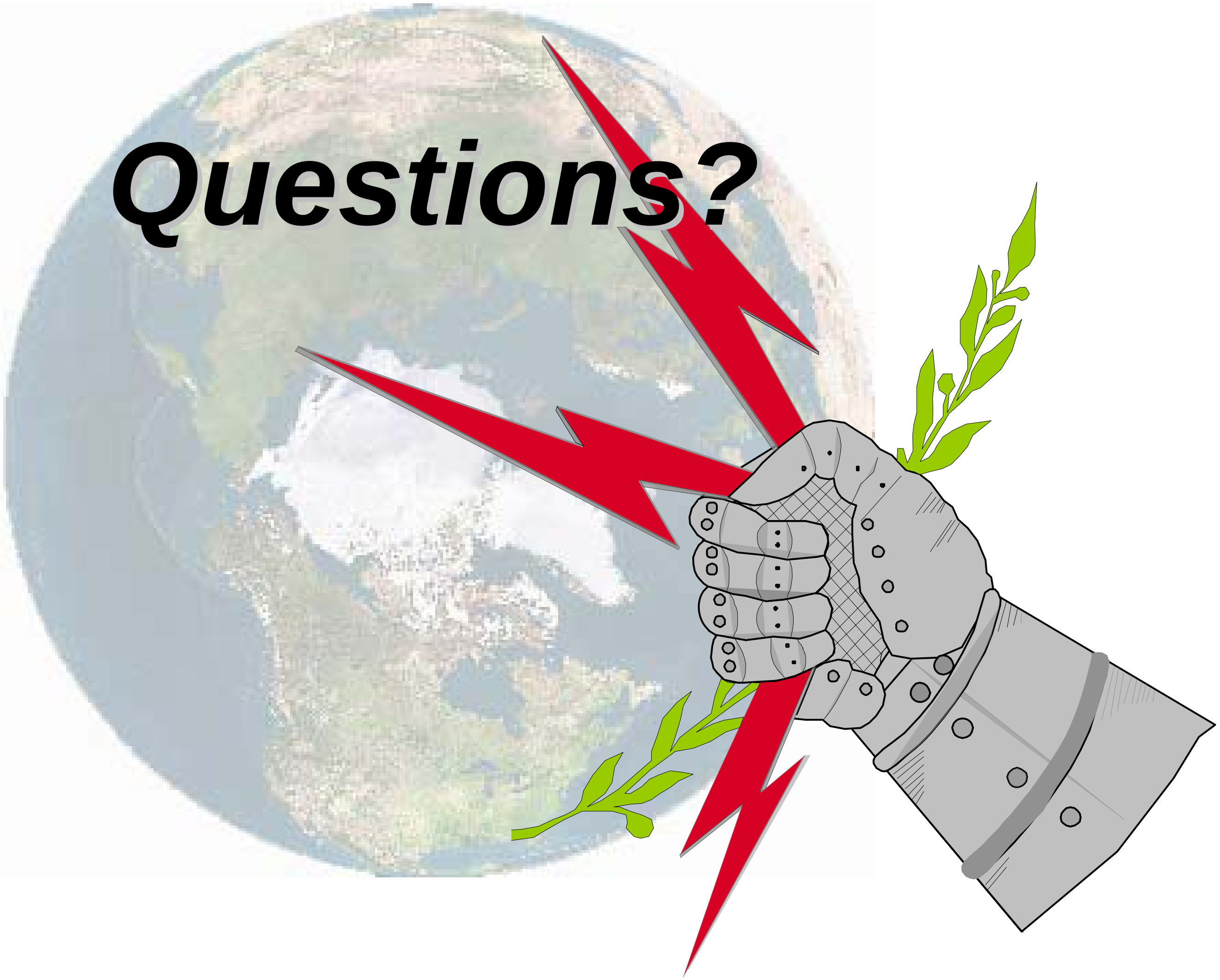
Regional
(Thin or Thick Client)

Individual
(PDA)

Putting It Altogether



Questions?



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Welcome to the 8th Annual Science & Engineering Technology Conference/ DoD Tech Expo

April 17-19, 2007

FCS Technology Insertion and Transition

Dr. Paul Rogers

Executive Director of Research

Tank Automotive Research, Development & Engineering Center

Distribution Statement A. Approved for Public Release. Distribution is unlimited.

Ground Vehicle Systems and Support Equipment – For Today and Tomorrow

Current

70 ton main battle tank

Unarmored Tactical

100% Manned Systems

Conventional Power Trains

Passive Suspension

Steel Track

Periscopes

Conventional Armaments

Point to point Voice Communication

Enhancing the Current Force

Enabling the Future Force

Future

25-30 ton manned ground vehicle (FCS (BCT))

Armored Tactical

Combined Manned/ Unmanned Capabilities

Hybrid Electric Systems w/ exportable power

Active Suspension

Segmented Band Track

Indirect Vision Driving

High Power (EM) and Laser Weapons

Shared Common Operating Picture

Onboard Water Generation

Fire-Resistant Fuels

Laser Protection

Diagnostics/prognostics

Integrated C4ISR

RDECOM S&T Supporting FCS

Ground Vehicle Power and Mobility

EGTL

GVPM Programs

P&E SIL

Survivability

ARMOR

KE APS

Water from Air

Intelligent Systems

RVT Overview

Autonomous Platform

CHALLENGES

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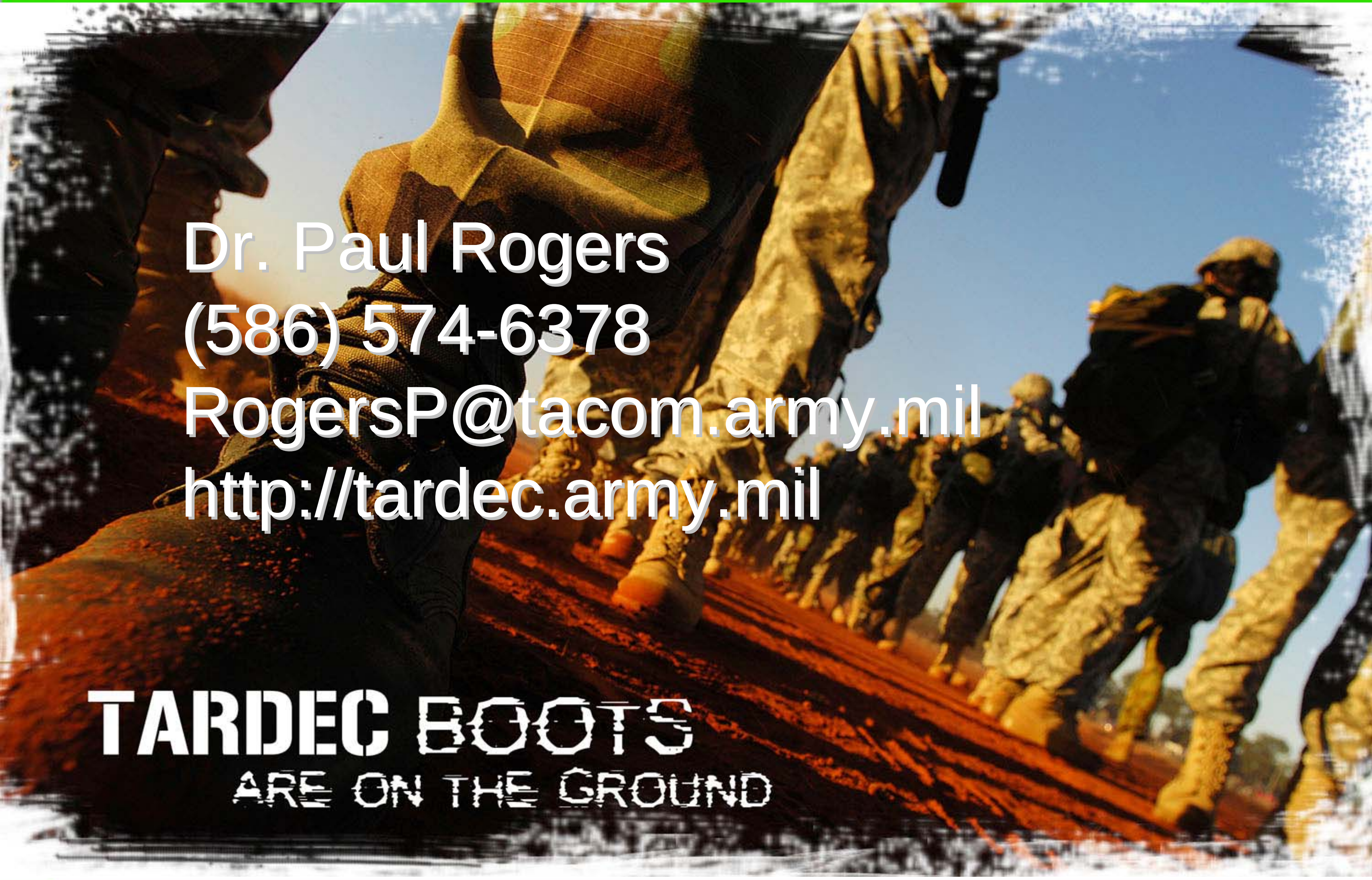

IBM Systems and Technology Group

Perspectives on Globalization & World Wide Collaborative Innovation for the Nation’s Defense

Raj Desai
Vice President, IBM Global Engineering Solutions,
A&D, Automotive, Travel & Transportation, Public Sector

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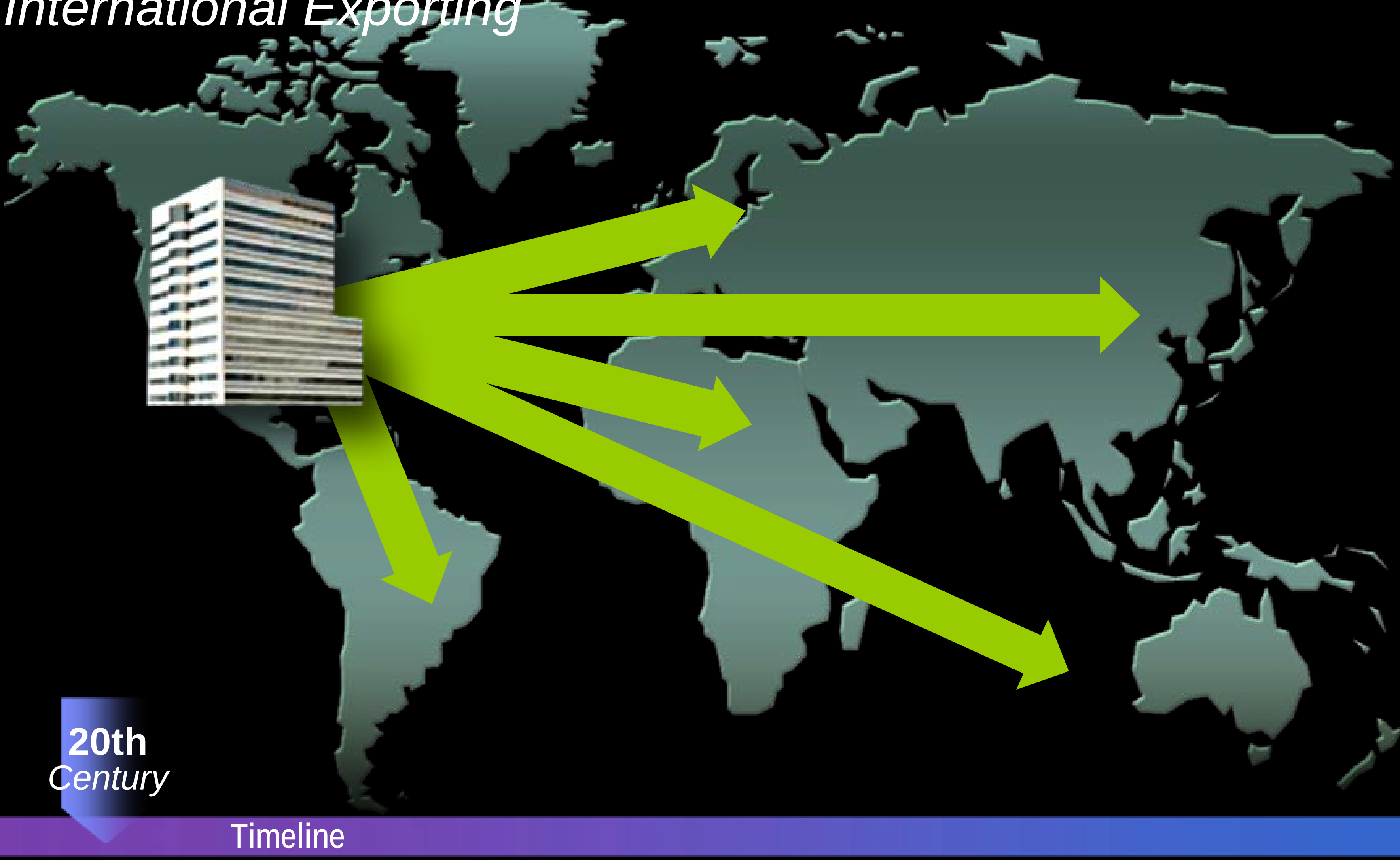
Globalization: the Journey…

International Exporting



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The Evolving Business Model

Multinational Country Silos

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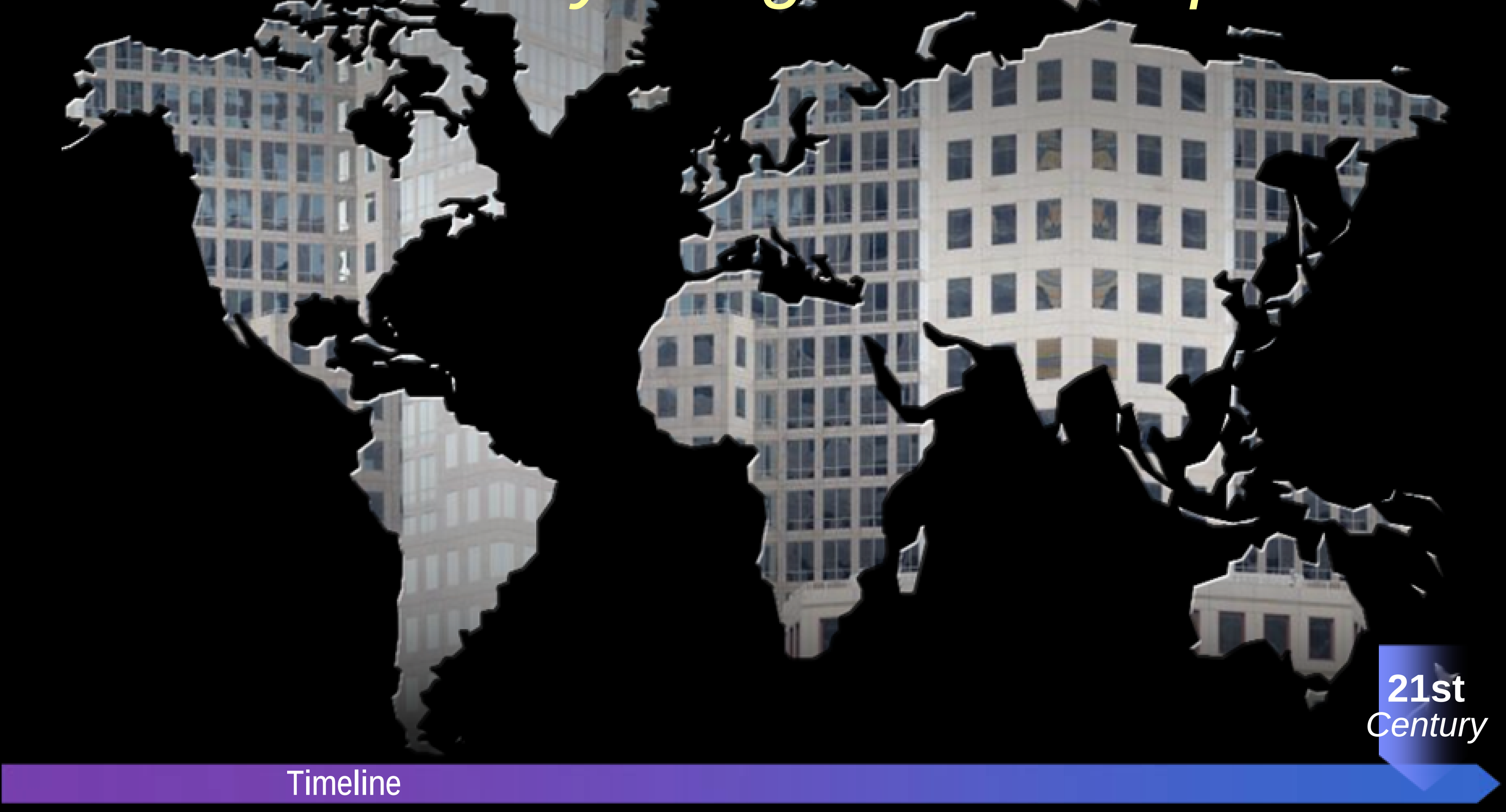
The Emerging Business Model

The Globally Integrated Enterprise



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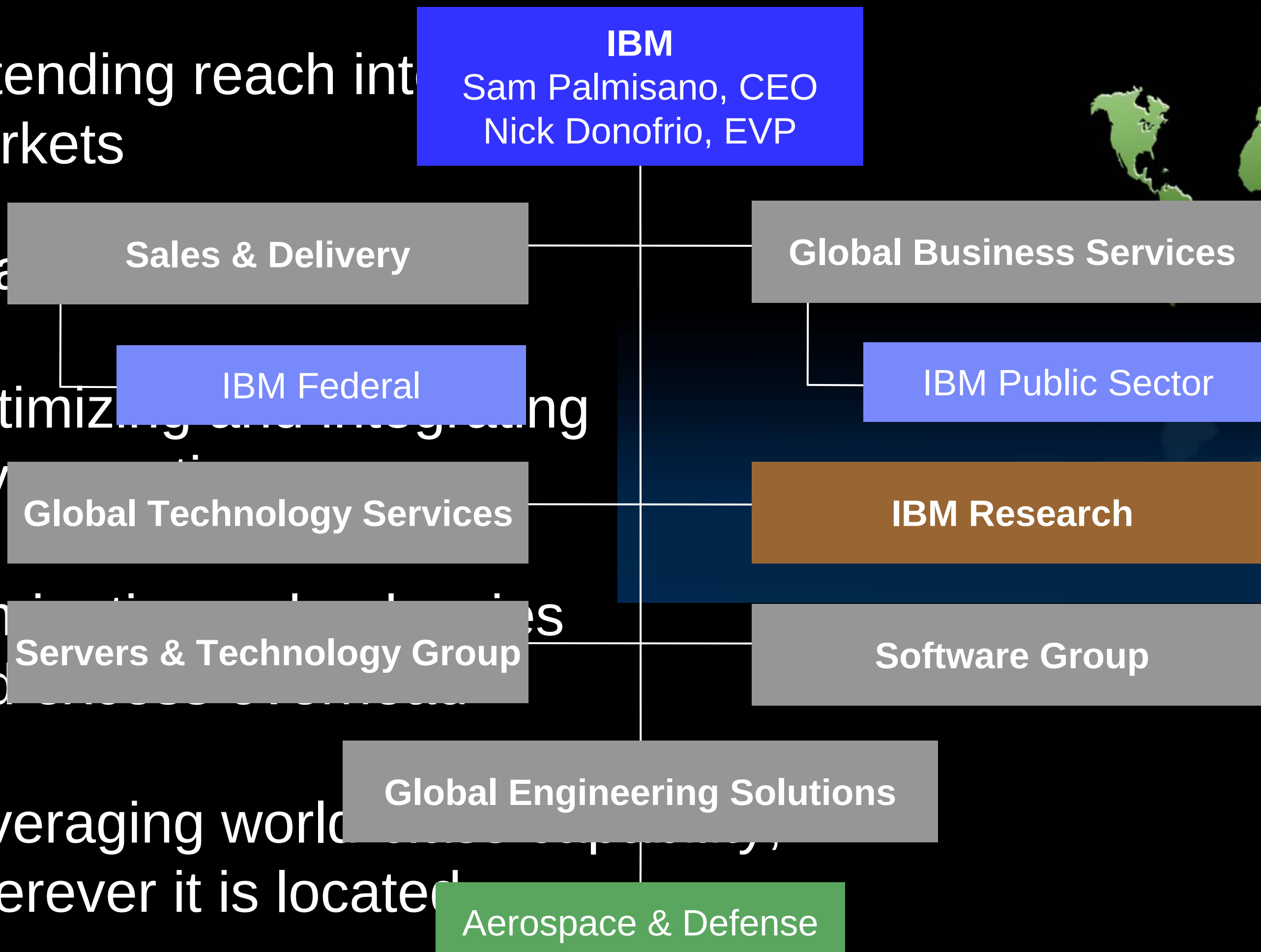
The Globally Integrated IBM

Making the Whole of IBM More Efficient

- Extending reach int
  markets
- Rea
- Optimiz ng
  key
- Elin es
  and
- Leveraging world ,
  wherever it is locate



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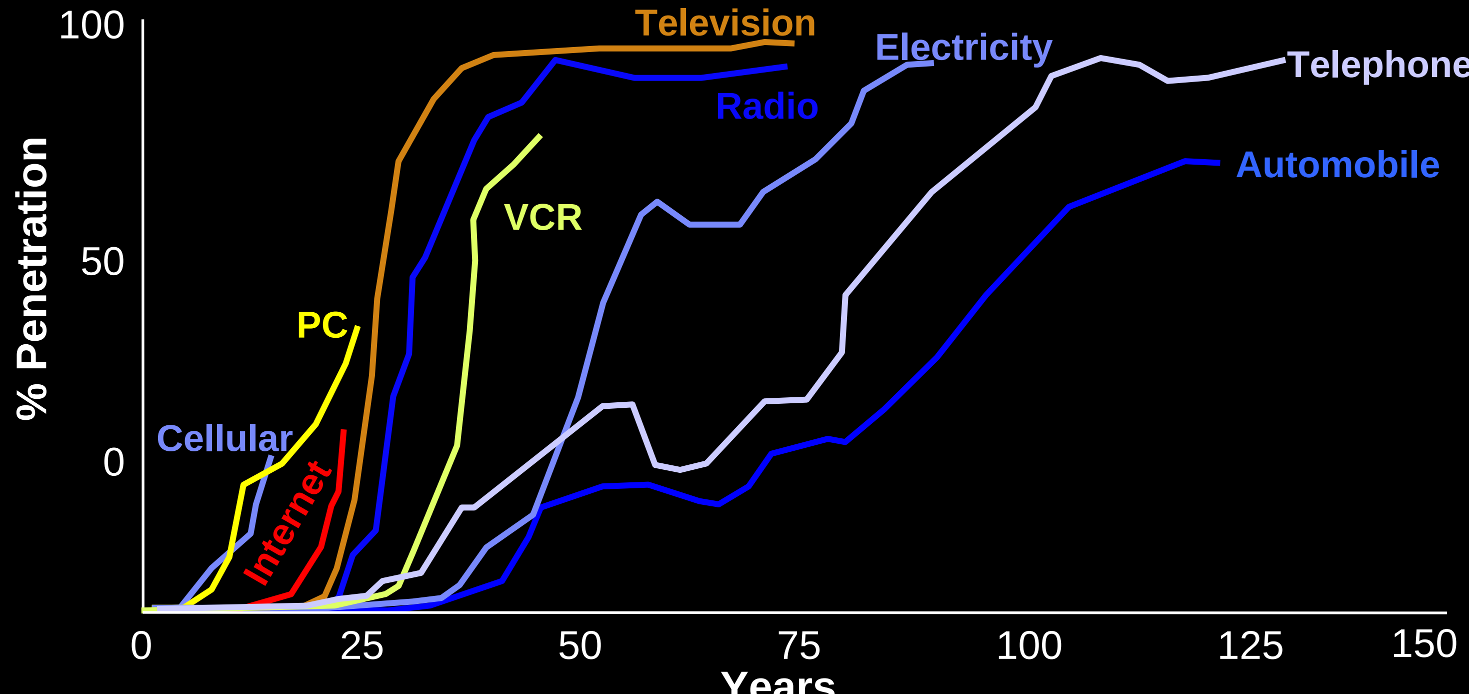
Pace of Commercial Technology Innovation is Accelerating

Defense Pressures

- **Newer technologies taking hold at double or triple previous rates**
- **Moore's Law vs. skills**
- **Globalization of Advanced Technology and Industry**
- **Declining Defense Dollars**



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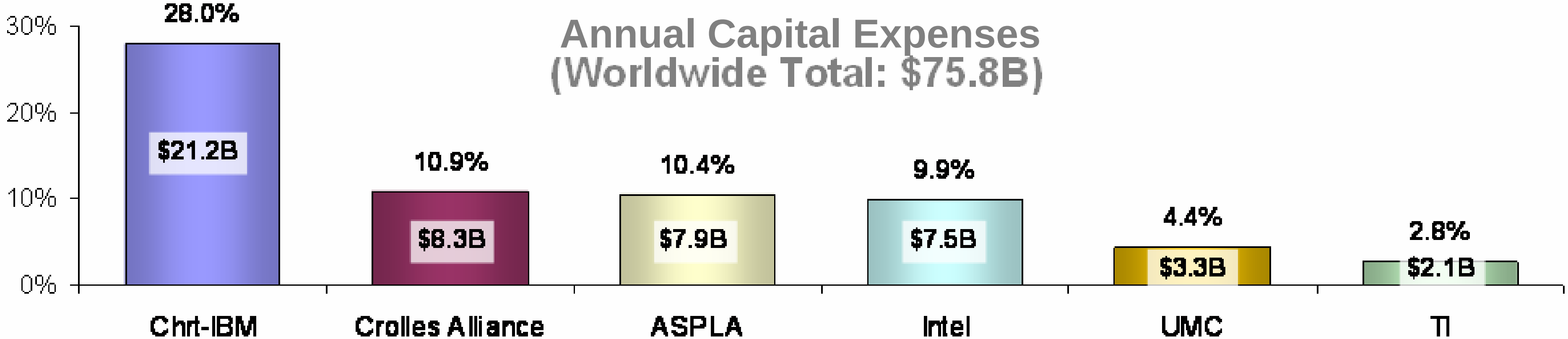
Soaring Cost of Development and Next Gen Manufacturing

Emergence of Strategic Development Alliances



Moving

Has announced plans to end in-house development. At 45nm and beyond will utilize TSMC Foundry.

Source: Gartner DQ (January 2005), Chartered

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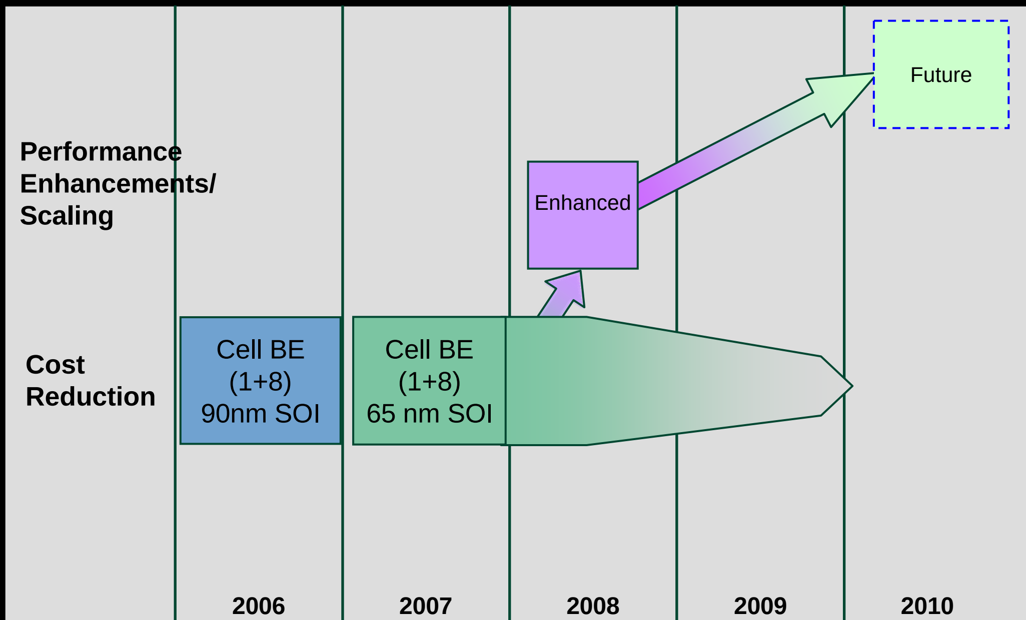
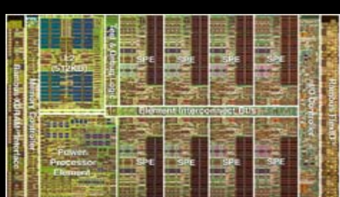
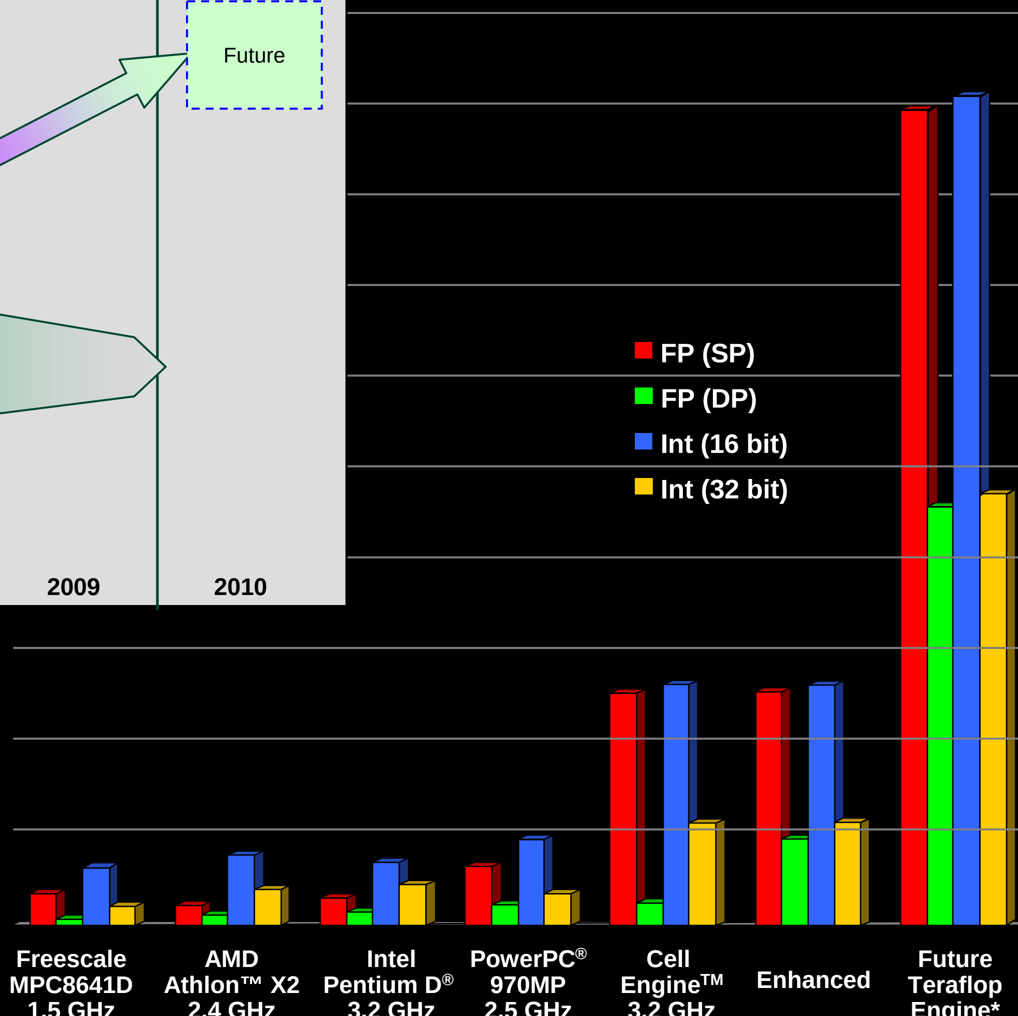
Example: *Gaming Technology Pushing the Processor Envelope (PS3, Xbox, Wii)*





Cell Engine™ 3.2 GHz

“Supercomputer on a chip”



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…for High Performance Computing Breakthroughs

- Cell & Power PC for Complex 4-D Visualization Exploitation
  - Cell Processor developed for Sony Play Station 3
  - Custom Power PC developed for Microsoft Xbox 360 and Nintendo Wii
  - ***This will revolutionize Geospatial Analysis and Battlefield Awareness***
- IBM Supercomputing dedicated to new Intelligence Missions
  - Blue Gene/L: Fastest Supercomputer in the World (six months old)
  - Most dense computing capability known to man (at Lawrence Livermore)
  - Blinding electronic speeds at low power levels for supercomputing
  - ***Los Alamos Road Runner Petaflop Supercomputer***
- Cell powered signal processing and advanced radar systems
  - Quantum leap of 15 – 30X in power for multi-function radars
  - Massive multi-cores along with efficient auto-code software enable portability
  - ***This will shrink weight while dramatically increasing functionality***
- UIMA Text Analysis & Imagery / JPEG / MPEG Analysis Developments
- High Speed All Source & Internet Content Analysis Techniques

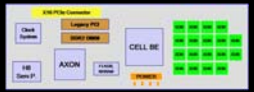
PlayStation 3

X Box 360

Nintendo Wii

Blue Gene / Road Runner

Cell/Soma Blades



Custom Cell based Boards

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Example: *MASTOR Speech-to-Speech Translation Technology*

- Completes English – Arabic & Arabic – English speech recognition and translation
- Provides visual aids so to assist users in accurate communication
- Adapts to each speaker despite differences in tones and accents
- Implemented for a language pair, optimized for "focused conversational domains"
- Accepts free form input in both languages, as opposed to "fixed phrase translation"
- **Leverages IBM's 35 years of commercial marketplace experience with practical issues in speech recognition**

Hand-held

Ruggedized Laptop

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Examples: *bringing Commercial Innovation to solving U.S. Government needs for advanced microelectronics solutions*

Leveraging best of commercial technology and processes to drive DOD imperatives defined in QDR and Defense Science Board task force studies on defense technologies

- **Trusted Foundry serves as a current example of this model**
  - Continued learning for both industry and U.S Government partners
- **Additional opportunities**
  - Radiation hardened (rad hard) microelectronics
  - Anti-tamper solutions, Trusted Software
  - Ultra high performance Systems, components and architectures
  - Ultra low power components, systems

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The Power of Commercial Leveraged for Defense

- Historically the Defense Industry drove significant technology creation and many of today's high-tech companies are the direct beneficiaries
- The dynamic has changed…
- In today's global economy, a strong, viable, USA Commercial Technology Industry is key to the future health of the US Government Defense
  - Three examples have been provided which demonstrate how commercial technology may be leveraged
- We have learned this is not easy to do, but we believe adoption is essential

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Back-Up

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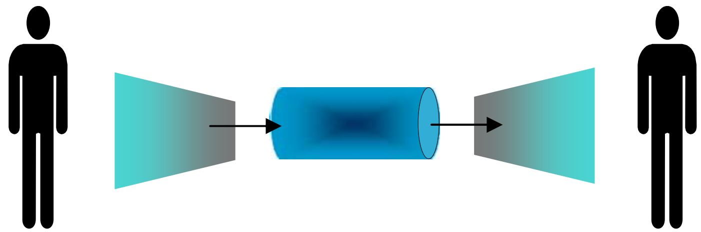
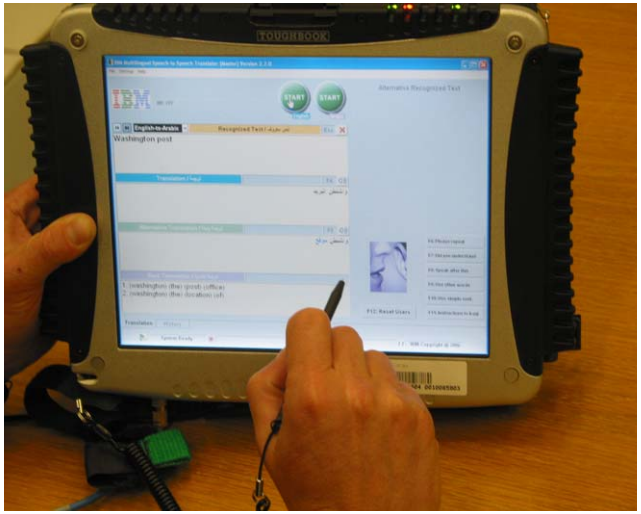
IBM Real-time Speech Translation Technologies



Today, IBM speech innovations are allowing media companies to monitor Chinese and Arabic news broadcasts over the Web in English, travelers to use PDAs to translate menus in Japanese, and doctors to communicate with patients in Spanish.

- IBM MASTOR - Multilingual Automatic Speech-to-Speech TranslatOR
- MIT Technology Review - ***One of "10 Emerging Technologies That Will Change Your World"***
- Time Magazine - ***" One of 5 New Things that Will Blow your Mind"***



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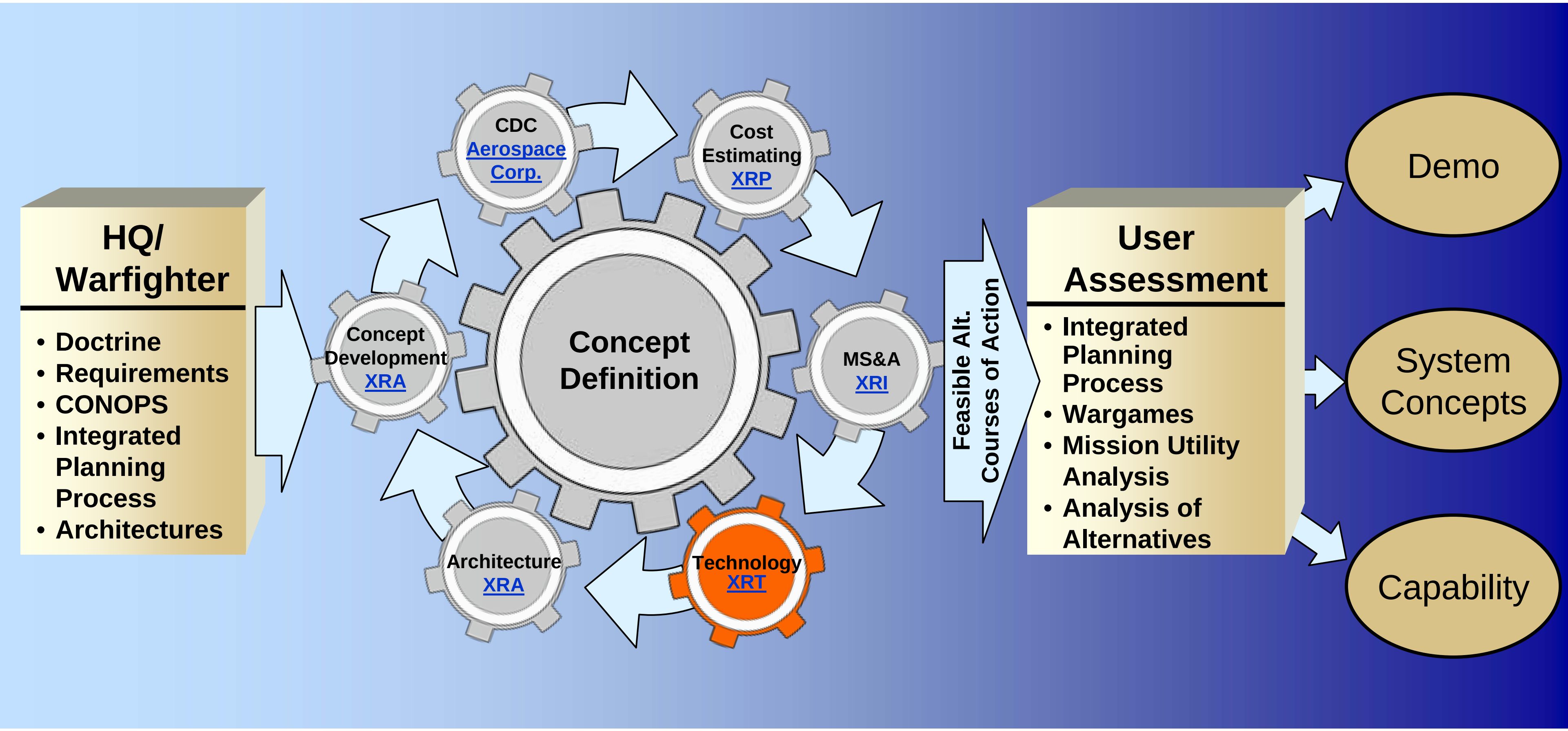
Program Office Perspective on Transformational Space

17 April 2007

RICHARD W. WHITE, JR., Colonel, USAF
Director, Developmental Planning

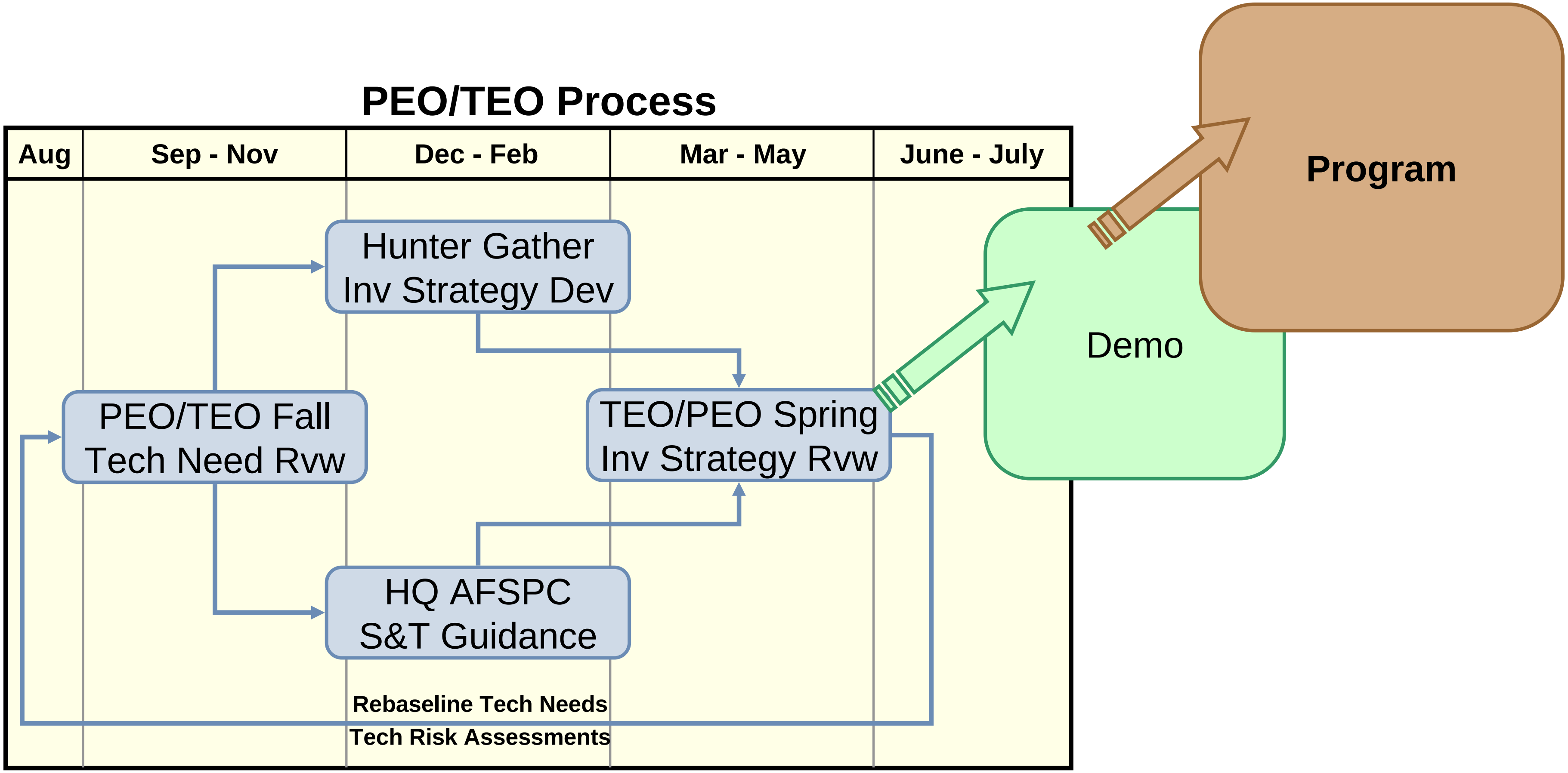
SMC/XR
Developmental Planning Process



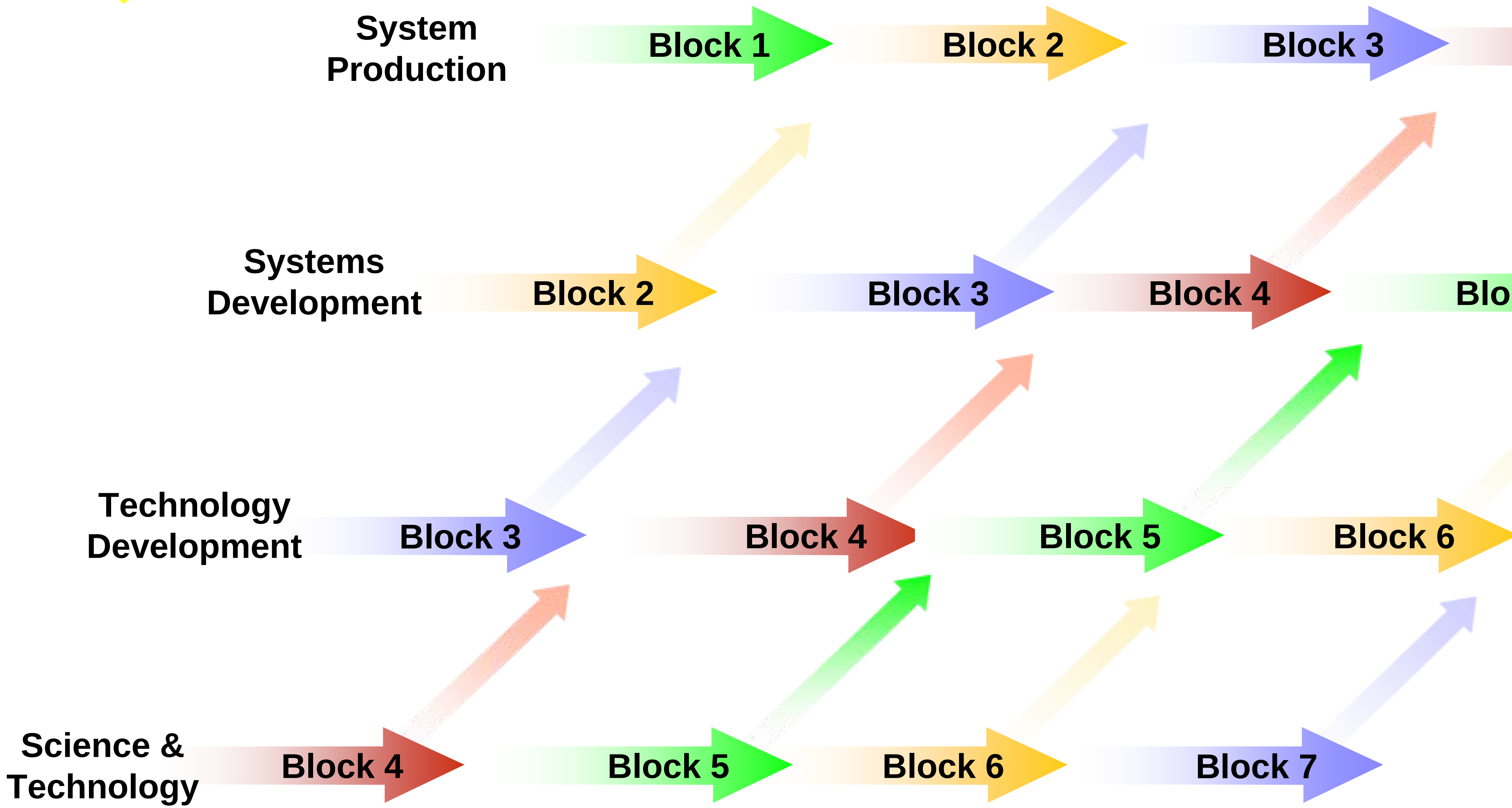
PEO/TEO Review Process

- **Fall 2006 PEO/TEO Review identified PEO tech Requirements**
  - **Deep dives between SMC/AFRL fleshed out tech issues**
  - **Presented summary of tech needs and technology roadmaps highlighting gaps and priorities**
  - **AFSPC A8X presented same tech needs in December S&T Council to establish foundation for S&T Guidance**
- **Spring 2007 PEO/TEO Response to PEO with S&T Guidance and Tech solutions**
  - **AFRL to brief status of tech roadmaps identifying potential solutions**
  - **AFSPC/A8 to briefs final AFSPC S&T guidance to S&T community**

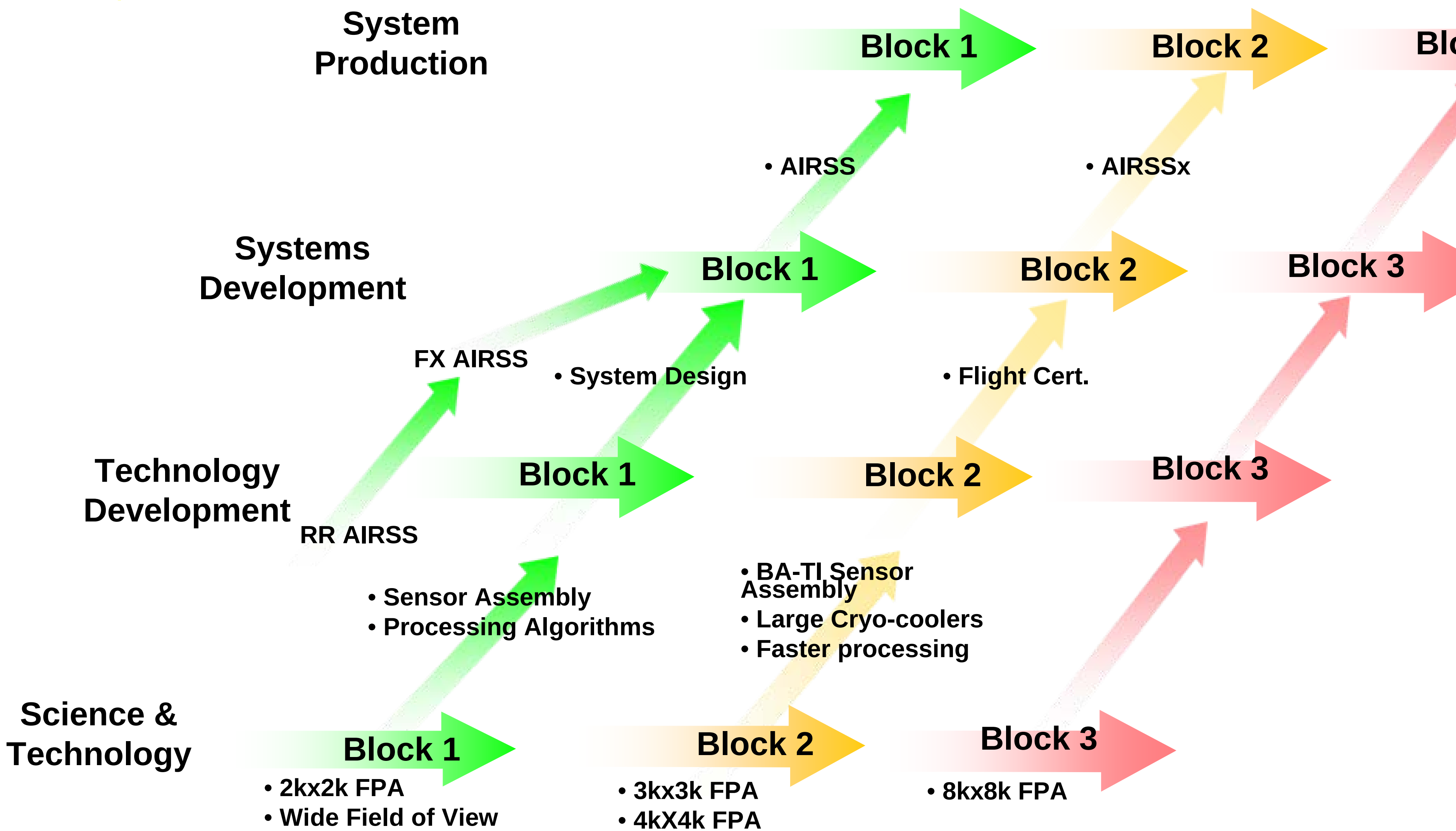
PEO/TEO Review Process



Acquisition Stages -- Block Approach



AIRSS Block Approach



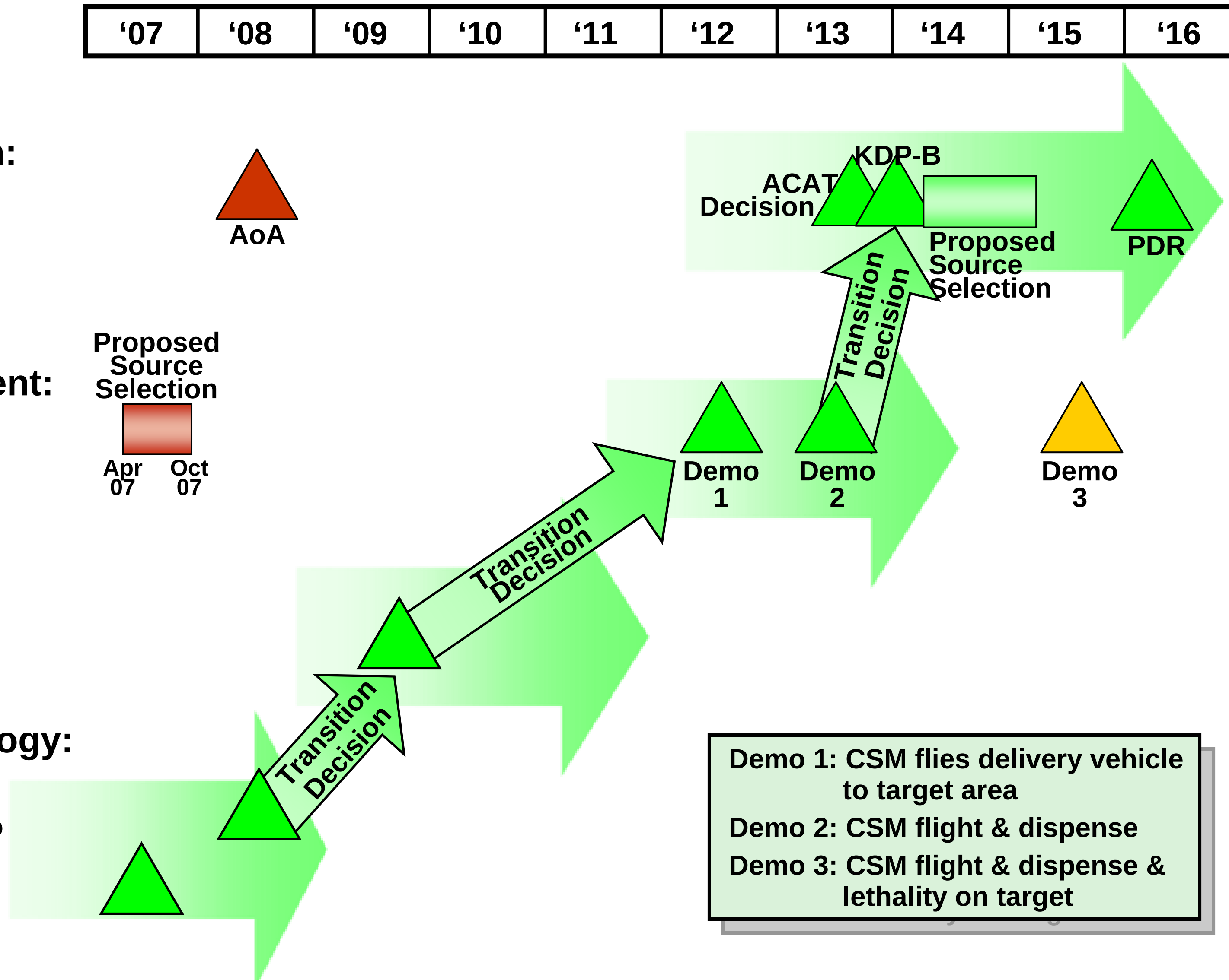
Proposed PGS Development Block Approach

System Production:
Operational PGS
Full & Open Competition

System Development:
Full Scale CSM Demos
Full & Open Competition

Technology Development:
Weapons Demos
• Pershing MTD-1P

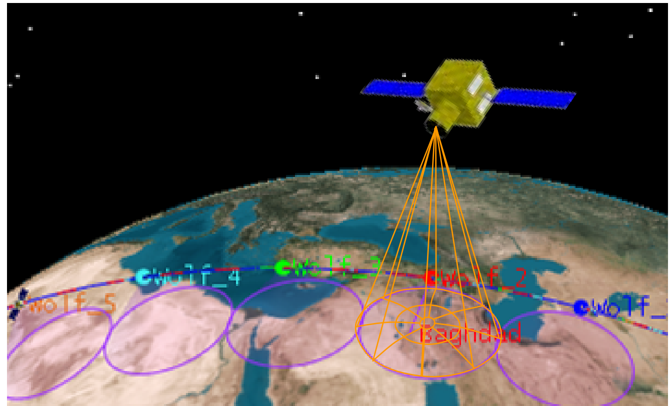
Science & Technology:
Technology Demos
• BLU-108 Lethality Demo
• Software Demo



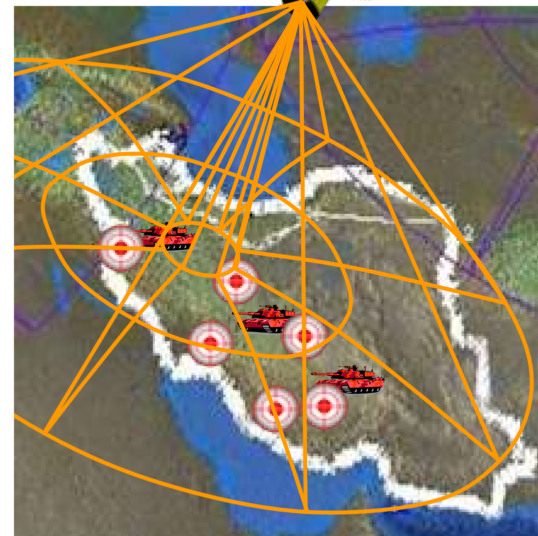
Unclassified

Modeling Simulation & Analysis

“Monster” Rack 40 Systems
(80-Core) for parallel processing

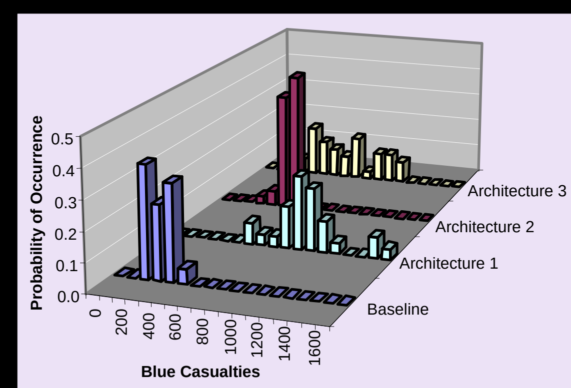


User-Defined Satellites
Unclass Screenshots from PISR Scenario Satellite Tool Kit



Customized Sensor Footprints
Unclass Screenshots from PISR Scenario SEAS v. 3.7

Fully Programmable Blue Forces – Attempting to Intercept
Fully Programmable Red Forces – Attempting to Escape Country
Unclass Screenshots from PISR Scenario SEAS v. 3.7



Results

Conclusion

- **It is possible to push technology & manage risk down to an acceptable level**

- **Disciplined developmental planning & a block approach to acquisition are key enablers**

Fiscal Year 2008
President's Budget Request for
DoD Science & Technology

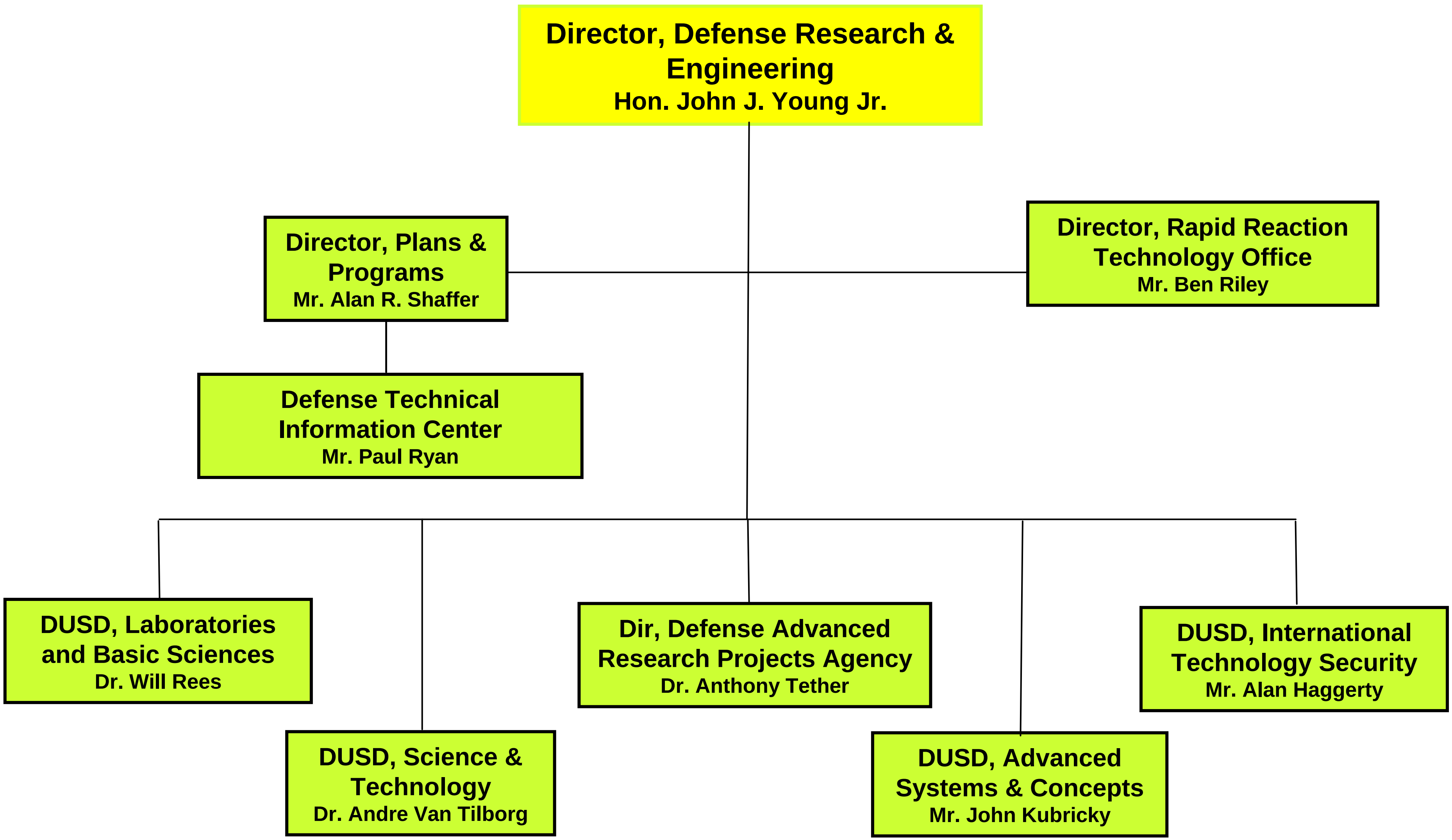
Mr. Bob Baker
Deputy Director, Plans and Programs
Office of the Director,
Defense Research and Engineering

Overview

- **PBR 2008 S&T Budget**
- **Budget changes and historical context**
- **Strategic foundation**
- **OSD / DDR&E programs, Reliance 21, R&E Portal**

PBR08—A year of transition
The growth of "non-kinetic", non-platform specific capabilities

DDR&E Organization



DDR&E Vision

Develop technology to defeat any adversary on any battlefield.

DDR&E Priorities for CY 2007

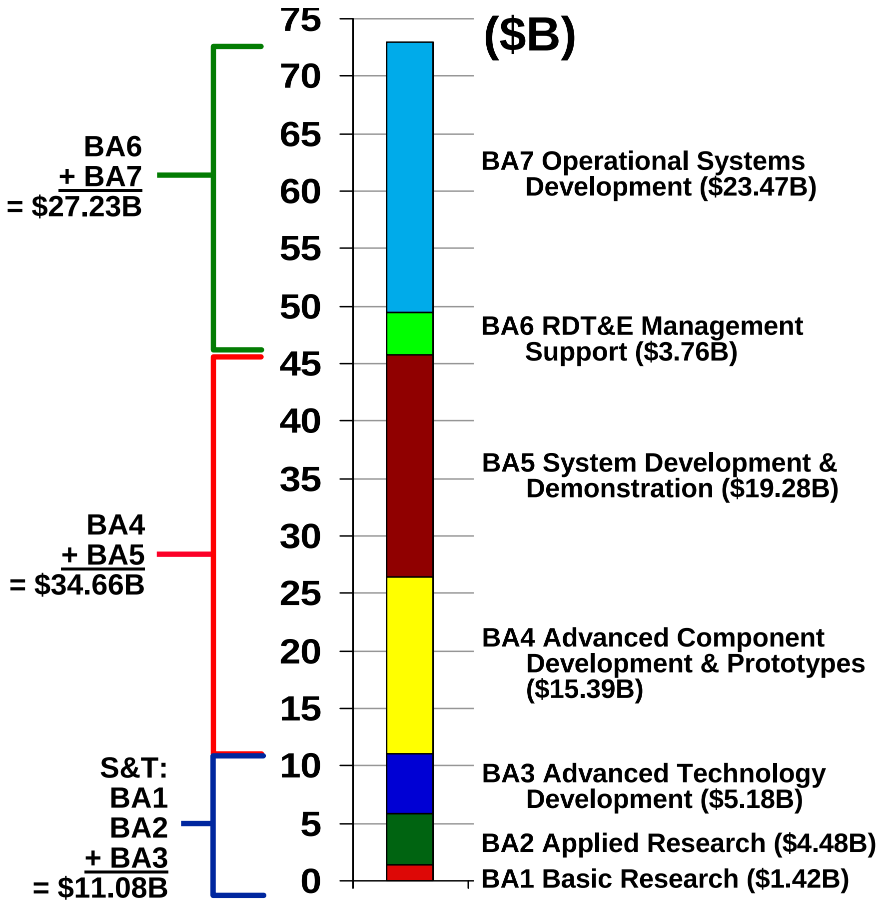
- **Support Global War on Terrorism**
- **Support Urban Operations Capabilities**
- **Support WMD Detection & Response Capabilities**
- **Develop Transformational Power & Energy Technologies**
- **Develop Manufacturing Technologies**
- **Enhance Technology Transition**
- **Enhance National Security S&E Workforce**

PBR 2008 S&T Budget

FY07 and FY08 RDT&E Budget Request Comparison

- in Then Year Dollars -

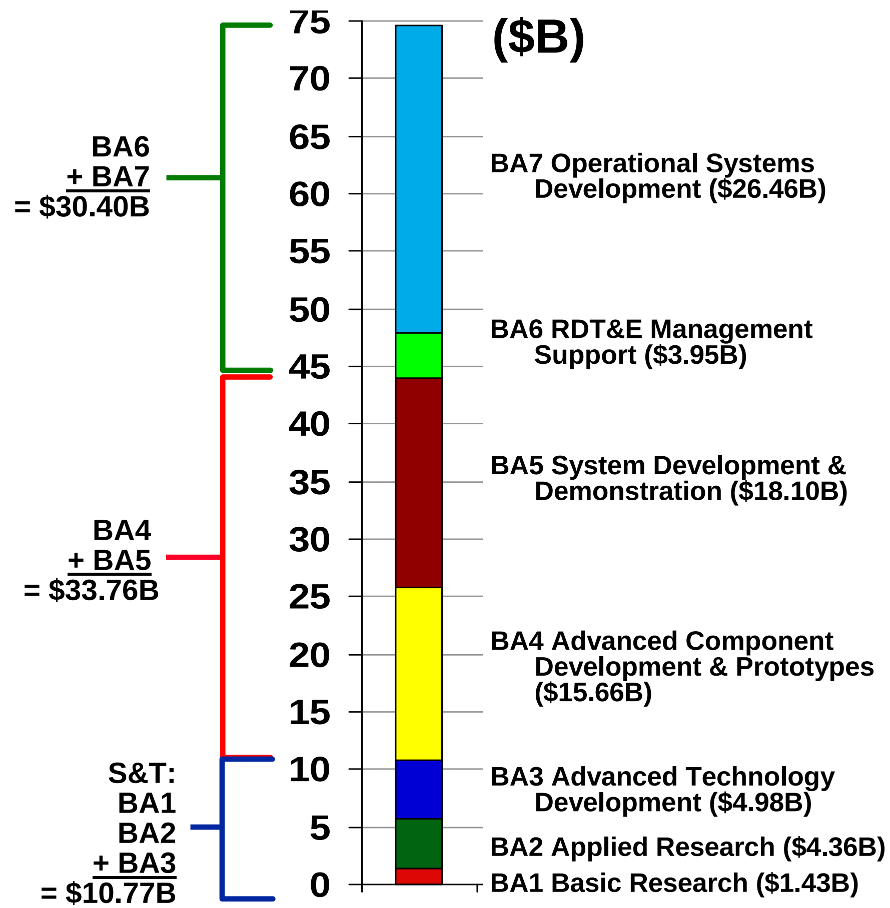
FY07 RDT&E request = $72.97B
(Budget Activities 1-7)



Technology Base (BA1 + BA2) = $5.90B

PBR07 S&T is 15.2% of RDT&E

FY08 RDT&E request = $74.94B
(Budget Activities 1-7)



Technology Base (BA1 +BA2) = $5.78B

PBR08 S&T is 14.4% of RDT&E

FY08 DoD R&E Budget Request Comparison

	FY07 PBR	FY07 Approp	FY08 PBR *(Constant Year FY07)*	Real Change (In CY $)
Basic Research (BA 1)	1,422	1,564	1,428 (*1,398*)	-1.7%
Applied Research (BA 2)	4,478	5,329	4,357 (*4,265*)	-5.0%
Advanced Technology Development (BA 3)	5,183	6,432	4,987 (*4,881*)	-6.2%
DoD S&T	**11,083**	**13,325**	**10,772 *(10,544)***	**-5.1%**
Advanced Component Development and Prototypes (BA 4)	15,387	15,789	15,662 (*15,331*)	-0.4%
DoD R&E (BAs 1 – 4)	**26,470**	**29,114**	**26,434 *(25,875)***	**-2.3%**

FY08 President's Budget Request is still well above historical levels

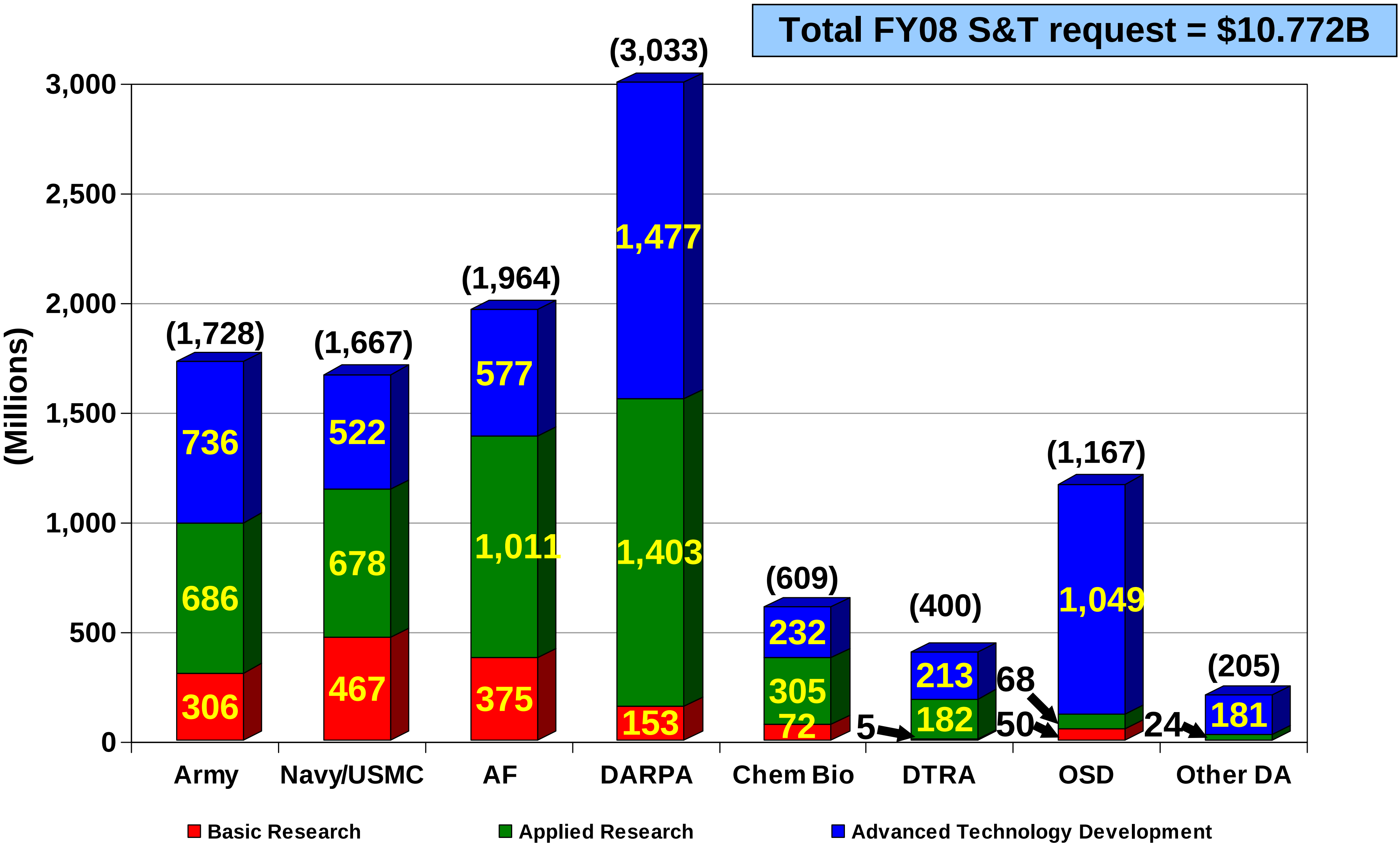
FY08 DoD R&E Budget Request Comparison
- Adjusting for Special Program Migration -*

	FY07 PBR (Adjusted For Special Programs)	FY07 Approp	FY08 PBR *(Constant Year FY07)*	Real Change (In CY $)
Basic Research (BA 1)	1,422	1,564	1,428 (*1,398*)	-1.7%
Applied Research (BA 2)	4,478	5,329	4,357 *(4,265)*	-5.0%
Advanced Technology Development (BA 3)	5,183 (4,867)	6,432	4,987 *(4,881)*	+.2
DoD S&T	**11,083 (10,767)**	**13,325**	**10,772 *(10,544)***	**-2.1%**
Advanced Component Development and Prototypes (BA 4)	15,387	15,789	15,662 *(15,331)*	-0.4%
DoD R&E (BAs 1 – 4)	**26,470 (26,154)**	**29,114**	**26,434 *(25,875)***	**-1.0%**

**** Note: FY 07 Budget Request Contained $316M in AF Special Programs; realigned in FY08***

FY08 President's Budget Request is still well above historical levels

FY08 DoD S&T Budget Request

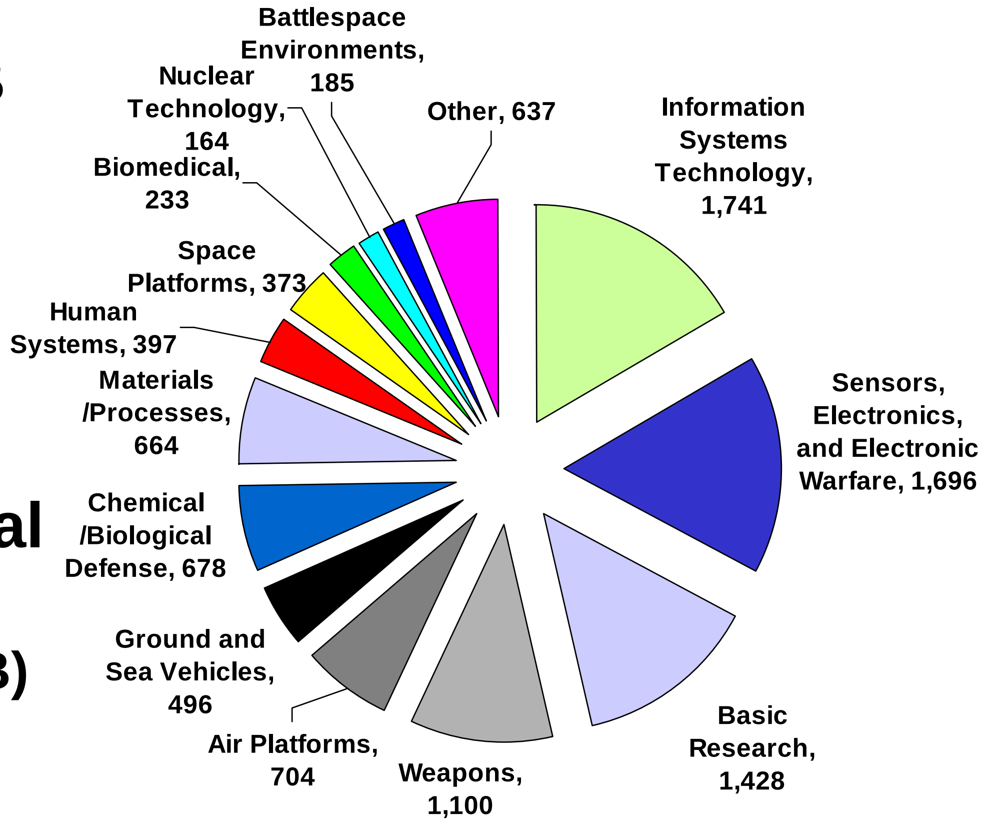


FY08 President's Budget Request

TY$M		FY08	FY09	FY10	FY11	FY12	FY13
ARMY	Basic Research	306	316	318	321	329	336
	Applied Research	686	671	676	684	690	703
	Advanced Development	736	715	704	709	726	742
	Total S&T	**1,728**	**1,702**	**1,698**	**1,713**	**1,745**	**1,781**
NAVY/	Basic Research	467	444	493	503	512	521
MARINE	Applied Research	678	613	622	635	667	695
CORPS	Advanced Development	522	533	592	626	614	605
	Total S&T	**1,667**	**1,590**	**1,707**	**1,764**	**1,792**	**1,822**
AIR	Basic Research	375	379	460	437	423	444
FORCE	Applied Research	1,011	1,003	1,145	1,070	1,066	1,096
	Advanced Development	577	542	738	680	626	675
	Total S&T	**1,964**	**1,924**	**2,342**	**2,188**	**2,115**	**2,215**
DEFENSE	Basic Research	280	282	307	325	336	341
-WIDE	Applied Research	1,982	2,070	2,083	2,035	2,083	2,128
	Advanced Development	3,152	3,507	3,541	3,323	3,404	3,439
	Total S&T	**5,413**	**5,859**	**5,931**	**5,683**	**5,824**	**5,908**
DoD	Basic Research	1,428	1,421	1,578	1,585	1,600	1,643
	Applied Research	4,357	4,358	4,525	4,424	4,506	4,622
	Advanced Development	4,987	5,297	5,575	5,338	5,370	5,461
	Total S&T	**10,772**	**11,075**	**11,678**	**11,347**	**11,476**	**11,726**

Characterization of the FY08 DoD S&T Program

- **Funding**
  - Then year S&T dollars: $11.08B FY07 to $10.77B FY08
  - Percent of total DoD funding: 2.52% FY07 to 2.24% FY08
  - Over 50% of total investment in 4 functional areas:
    - Information Systems (1.7B)
    - Sensors, Electronics / EW (1.7B)
    - Basic Research (1.4B)
    - Weapons (1.1B)



DoD S&T Program is focused on "Sensing and Shooting"

Budget Changes and Historical Context

S&T Program Changes for Fiscal Year 2008

- **Refocus in response to the QDR toward "non-kinetic" technologies:**
  - **Clandestine Tagging, Tracking and Locating;**
  - **Biometrics;**
  - **Human, Cultural, Social Behavior Modeling;**
  - **Networks;**
    - **Airborne Network Gateways**
    - **Network Science**
  - **Persistent Surveillance;**
  - **Sensor Weapon Pairing**

- **Refocus to lower acquisition and operations & maintenance costs:**
  - **Technologies to Decrease Energy Consumption/Increase Alternatives**
  - **Manufacturing Technology S&T**
  - **High Performance Computational Tools for Acquisition Streamlining**

FY08 request includes $1.6B of OSD directed changes, across the FYDP, to develop new technologies for new capabilities.

DoD TOA Comparison

DoD TOA by Category

Changes by Appropriation	PBR07	PBR08	$ Change	% Change
MILPERS - Active	92,947	97,135	4,188	4.31%
MILPERS - Reserve	17,830	19,145	1,315	6.87%
TOTAL MILPERS	***110,777***	***116,280***	***5,503***	***4.73%***
O&M	*152,008*	*164,686*	*12,678*	*7.70%*
Procurement	*84,197*	*101,679*	*17,482*	*17.19%*
RDTE	73,156	75,117	1,961	2.61%
MilCon	12,614	18,233	5,619	30.82%
Family Housing	4,345	3,106	-1,239	-39.89%
Revolving Funds	2,436	2,454	18	0.73%
	439,533	**481,555**	**42,022**	**8.73%**

Changes by Component	PBR07	PBR08	$ Change	% Change
Army	*111,712*	*130,106*	*18,394*	*14.14%*
DoN	*127,322*	*139,810*	*12,488*	*8.93%*
AF	130,386	136,561	6,175	4.52%
DW	70,114	75,078	4,964	6.61%
DoD TOA	**439,534**	**481,555**	**42,021**	**8.73%**

Major changes:

***Army**:*

Procurement +$6.9B, primarily in Tactical and Support Vehicles, Comms and Electronics;

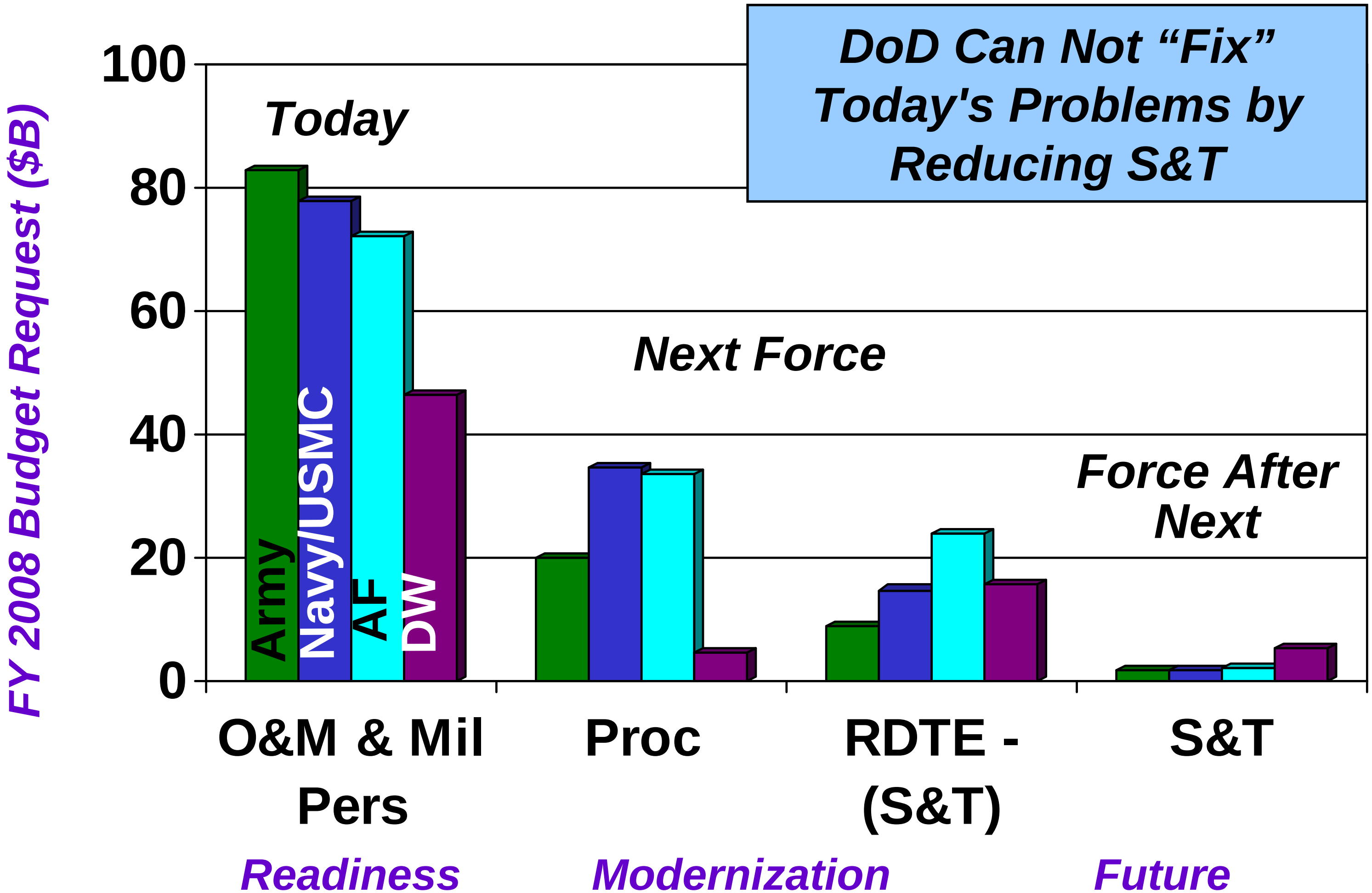
O&M +$5.7B, primarily in Active forces

***Navy**:*

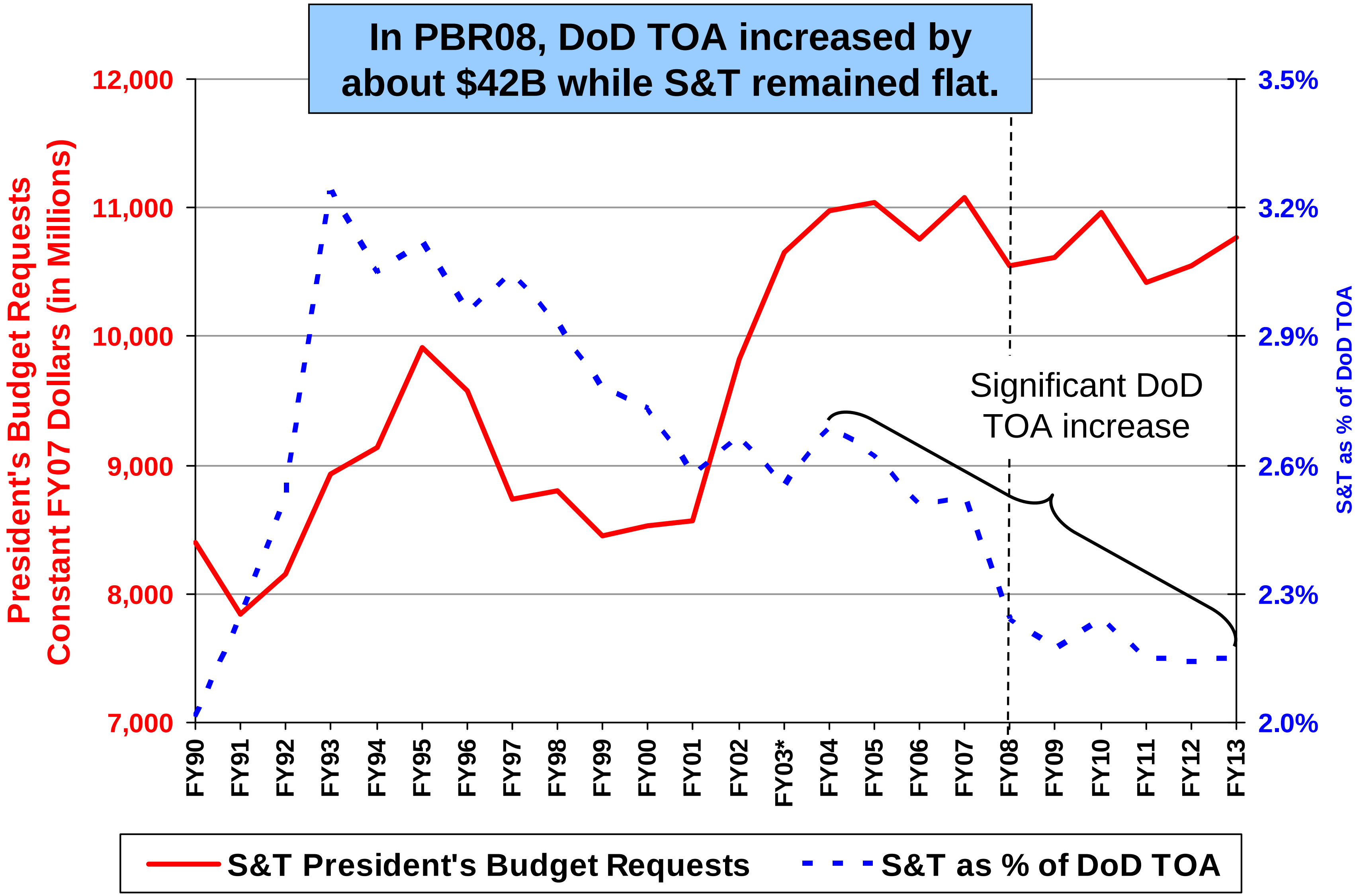
Procurement +$8.8B, primarily in Ship Construction (CVN-21, LPD-17), Combat Aircraft and USMC Ground Vehicles;

O&M +$3B, primarily in Ship Operations with an increase in underway days per quarter

Technology Investment Compared to Other DoD Categories



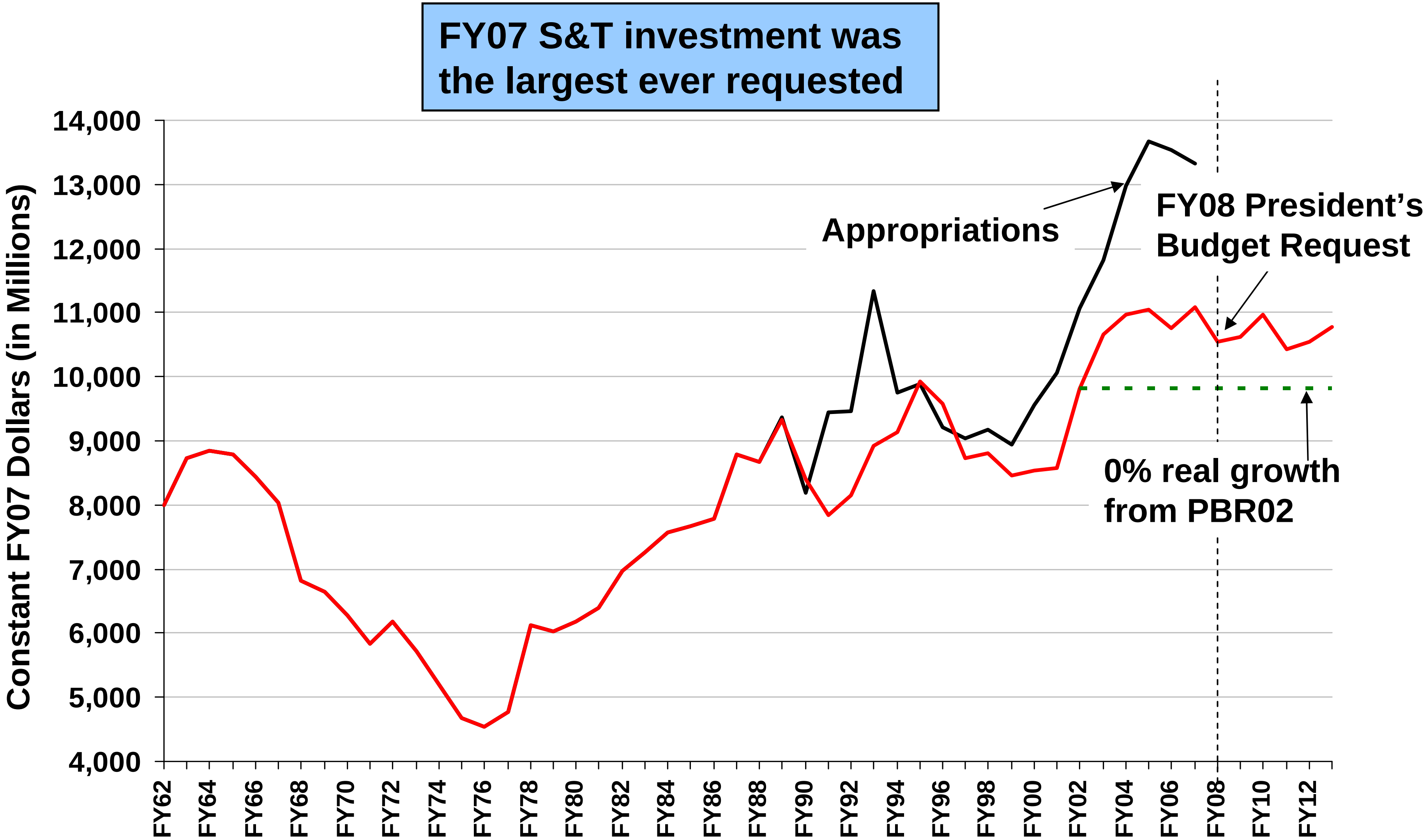
DoD S&T - Macro Scale
- S&T Investment and % of DoD Total Obligation Authority (TOA) -



** ***Note:*** FY03 includes DERF & Nuclear Posture Review funding

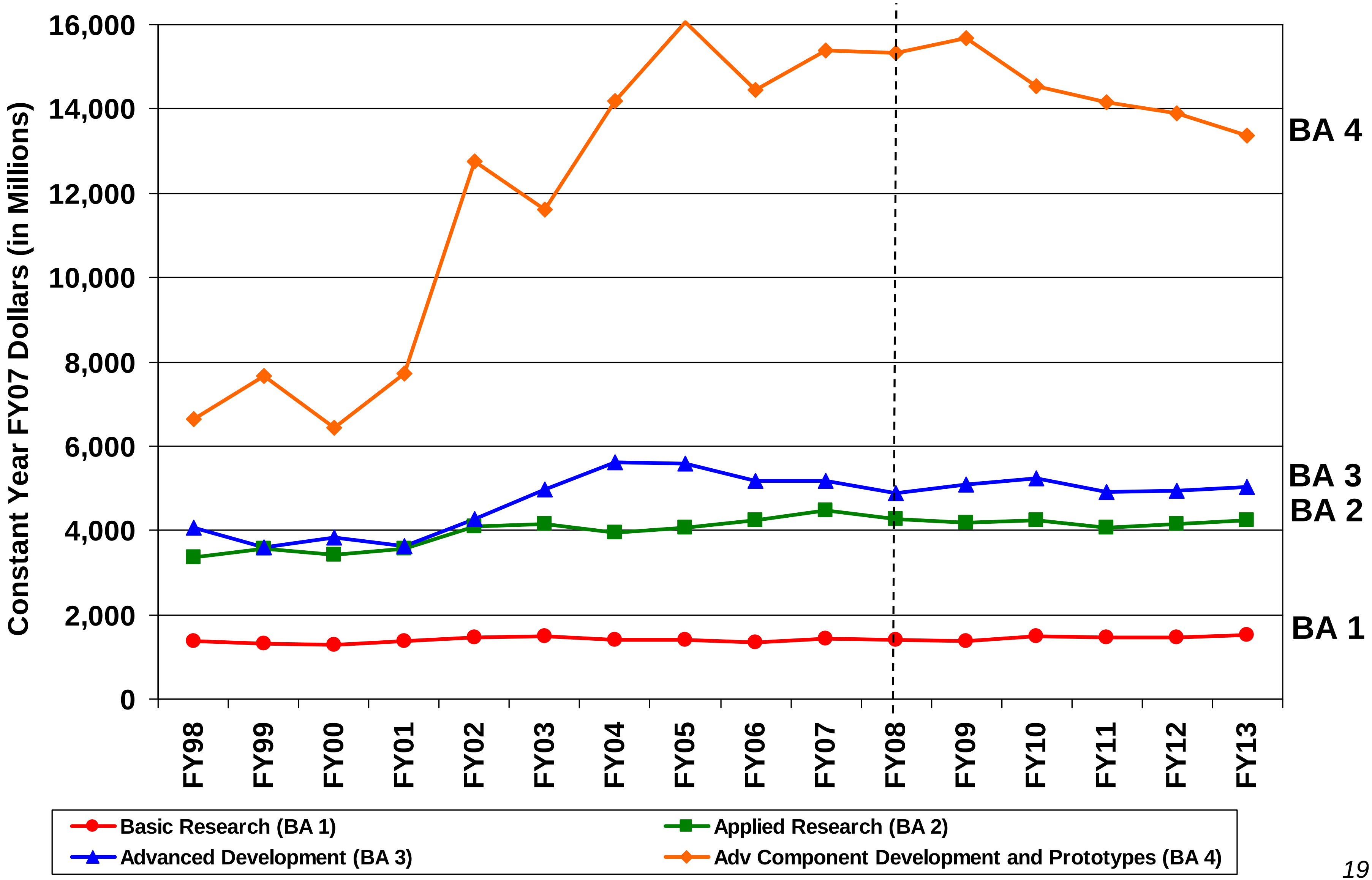
DoD S&T – Historical Context

- In FY07 Constant Dollars -

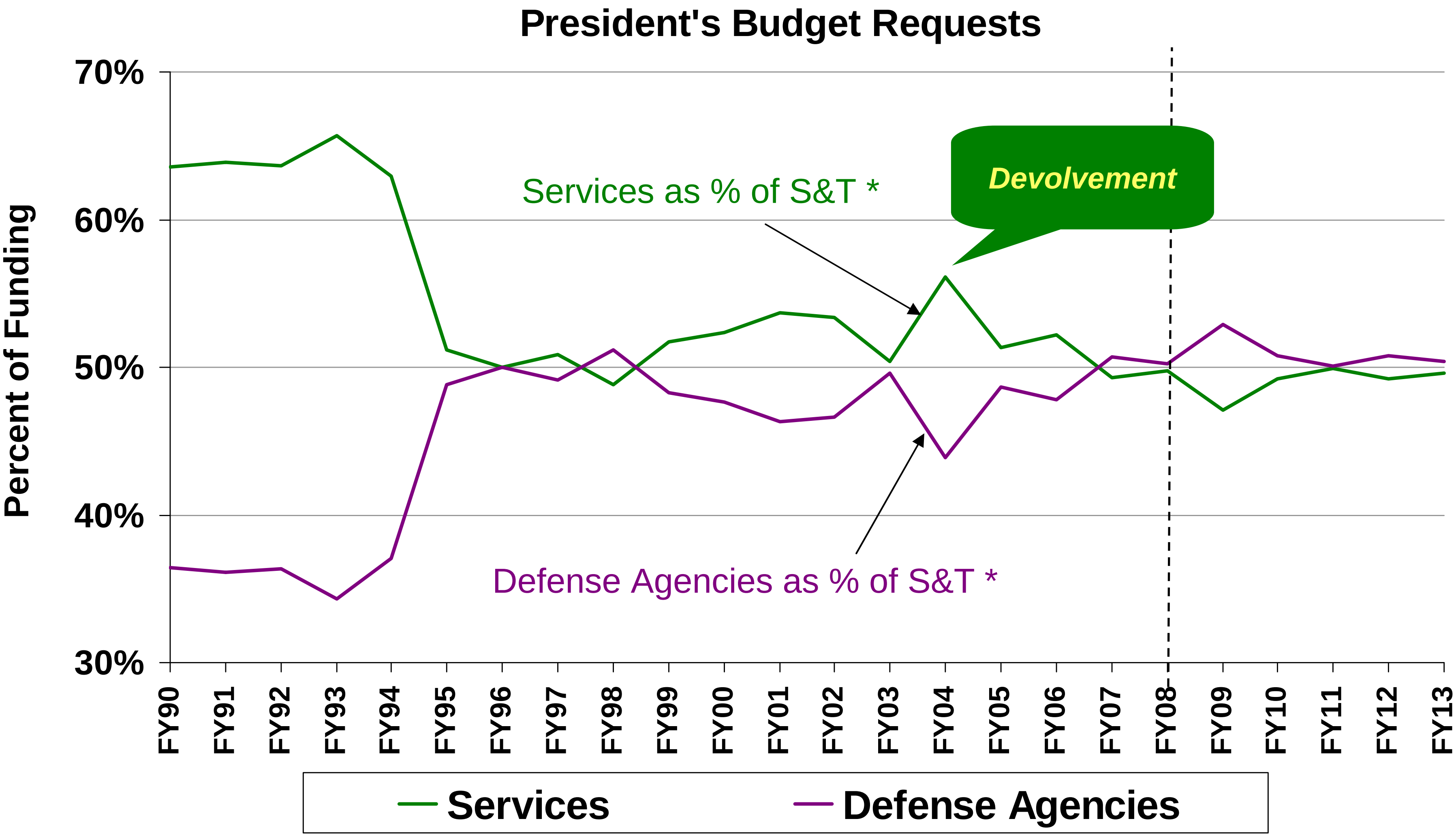


In FY03, includes $203M allocated to Def Emergency Response Fund (DERF) S&T in a separate DoD transfer account

DoD R&E Funding By Budget Activity
- President's Budget Requests - in FY07 Constant Dollars -



S&T Breakout
- Services and Defense Agencies as % of Total S&T -



** ***Note:*** Devolved programs in FY04 perturbed program

Strategic Context

Strategic Framework

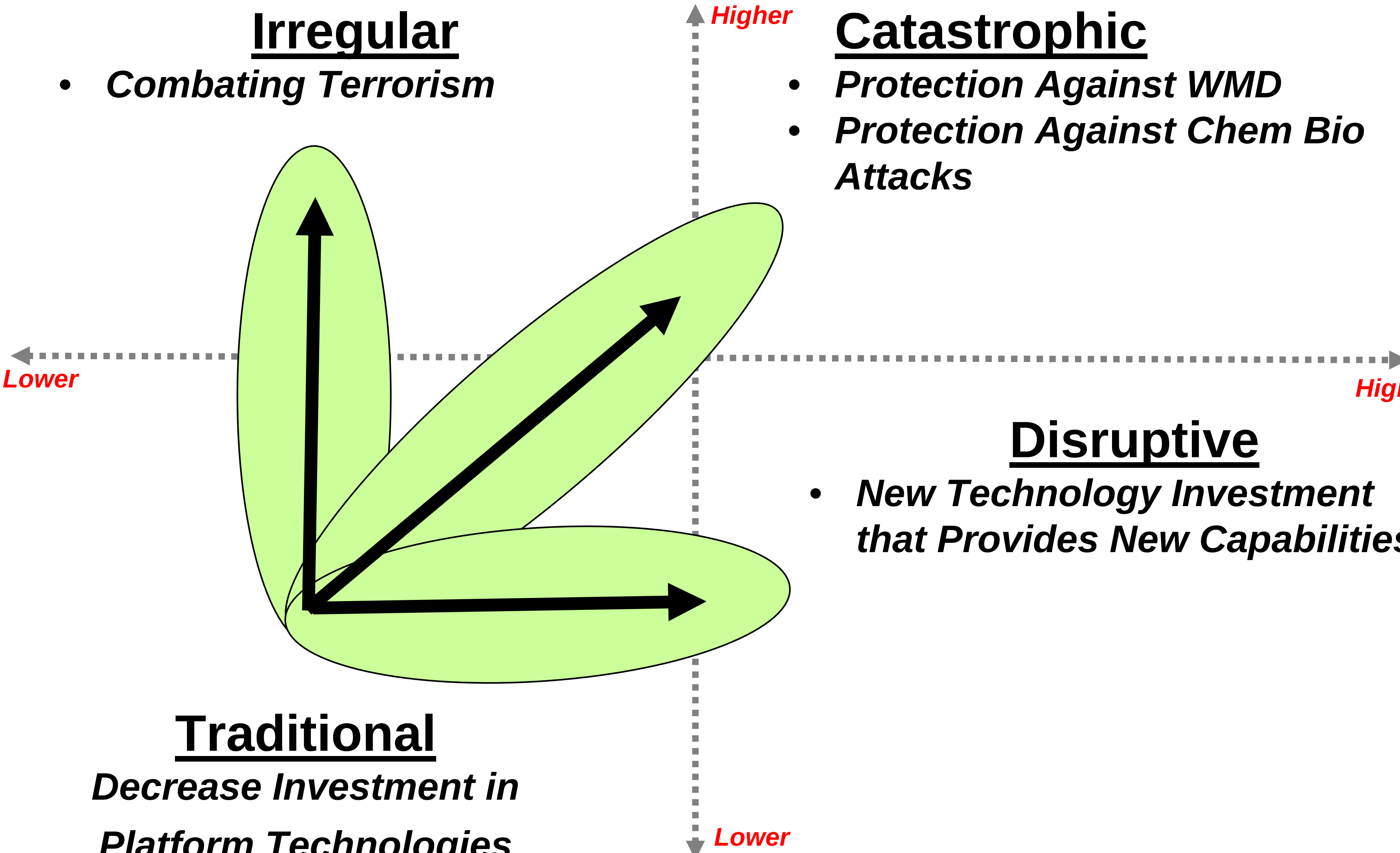
- **US National Security Strategy (March 2006) set national imperative to continue the war on terrorism**
- **2006 Quadrennial Defense Review also restated the need for DoD to balance its capabilities across four categories of challenges:**
  - Traditional
  - Irregular
  - Catastrophic
  - Disruptive

Transformational

National Defense Strategy Drives Investment Strategy

Irregular
- *Combating Terrorism*

Catastrophic
- *Protection Against WMD*
- *Protection Against Chem Bio Attacks*



Disruptive
- *New Technology Investment that Provides New Capabilities*

Traditional
Decrease Investment in Platform Technologies

R&E Funds Transformational Technologies
- Investment Priority Changes from PBR07 to PBR08 -

VULNERABILITY

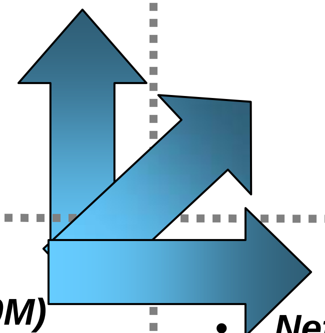
Irregular

- *Explosive ordnance disposal (Navy $+59M)*
- *Clandestine tagging, tracking and locating (SOCOM $+25M)*
- *Human systems and modeling (OSD $+22M)*
- *Non-lethal techs (USMC $+10M)*
- *Hyperspectral imaging (OSD $+10M)*
- *Biometrics (OSD $+8M)*

Higher

Catastrophic

- *Hard and deeply buried targets (Navy $+49M)*
- *Biological defense techs (CBDP $+23M, DARP $ +9M)*
- *Missile and Rocket Adv Tech (Amy $+18M)*



Lower

Traditional

- *Marine Corps ground vehicles ($+180M)*
- *Tank lethality and survivability (Army $+137M)*
- *Conventional missiles, ammunition (Army $+98M)*
- *Aerospace vehicle technology integration (AF +37M)*
- *LCS (Navy $-102M)*
- *Carrier Systems Development (Navy $-69M)*
- *Next Generation Bomber (AF $-26M)*
- *Intercont Ballistic Missile (AF $-19M)*

Higher

Disruptive

- *Network Communications (Army, $+64M, OSD $+40M)*
- *Energy Efficiency (Army, Navy, AF, OSD $+36M)*
- *National Defense Education Program (OSD $+25M)*
- *C3I research and development (DARPA $+24M,)*
- *Operationally Responsive Space (AF $+51M)*
- *Joint Non-Lethal Weapons Tech (Navy $+10M)*

Lower

LIKELIHOOD

Overview of DDR&E Programs, Reliance 21, R&E Portal

DDR&E PBR08 Thrust Areas

--New "D" Line Programs in Blue--

- **Addresses QDR and SPG Capability Needs**
  - **Capabilities to Defeat Terrorist Networks**
    - **Biometrics (PE 0603665D8Z) $8M FY08, $69.5M FYDP**
    - **Human, Social, Cultural, and Behavioral Modeling (0602670D8Z; 0603670D8Z; 0604670D8Z) $22M FY08, $212M FYDP**
    - **Clandestine Tagging, Tracking, and Locating**
    - **Airborne Hyperspectral**
    - **Synthetic Aperture Radar Change Detection (0603745D8Z) $6.5 M FY08, $19.5M FYDP)**
  - **Capabilities to Defend the Homeland in Depth**
    - **Joint Integrated Fire Control**
    - **Network Communications Capabilities (0603662D8Z) $40M FY08, $190M FYDP**
    - **Airborne Network Gateway (0603662D8Z)**
  - **Acquisition Affordability**
    - **Defense-Wide Manufacturing Science & Technology (0603680D8Z) $10M FY08, $80M FYDP**
    - **Insensitive Munitions Advanced Technology (0603000D8Z) $6.0M FY08, $109M FYDP**
    - **Computational Research and Engineering Acquisition Tools and Environments (Project in High Performance Computing)**
  - **Other**
    - **Iridium Global Positioning System**
    - **Energy Systems**

Defense S&T Reliance

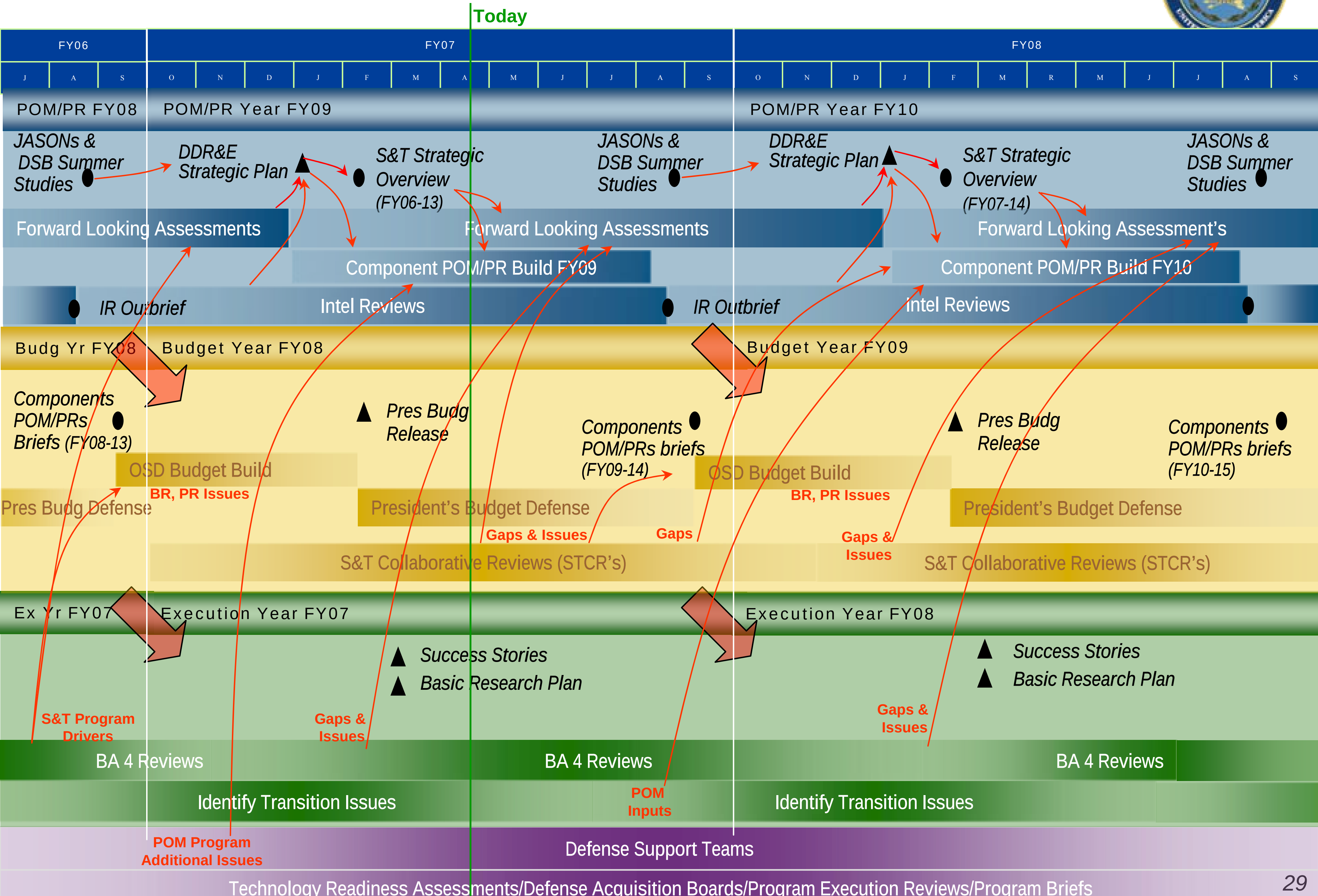
Defense S&T Reliance provides the framework to enable the DoD S&T community to work together to enhance the Defense S&T program and eliminate unwarranted duplication. It strengthens cooperation among the Services and Agencies thereby improving responsiveness to their warfighting and acquisition customers.

S&T Plans and Reliance 21

Defense Science and Technology Strategy and Plans

- ***Defense S&T Strategy (Being replaced with DDR&E Strategic Plan)***
- ***Basic Research Plan (6.1) - BRP - (Biennial, odd years)***
- ***Defense Technology Area Plan (6.2, 6.3) - DTAP - (Being replaced with Technology Focus Teams)***
- ***Joint Warfighting Science and Technology Plan - JWSTP (Biennial, even years)***
- ***Defense Technology Objectives (DTO) Volume that supports JWSTP and DTAP (Going away)***

Reliance 21 Timeline



Reliance 21 Products

• DDR&E Strategic Plan	Draft
• Basic Research Plan	Draft
• Component S&T Plans	Mar 07
• Success Stories	Mar 07
• Joint Warfighting S&T Plan	Mar 08
• Technology Focus Teams	Ongoing

Associated Products

• Forward Looking Assessments	Ongoing
• Intelligence Reviews	Ongoing

Technical Information Issues

- Timescale on getting the answers to operational and technical questions is increasingly shorter
- Efficient access to accurate technical information is vital to ensuring the DoD is responsive to future threats
- The rate of change of technology and the volume of global technology information are increasing
- Information is scattered and controlled by multiple access limitations

DoD R&E
"Information Transformation"

Every DoD Researcher, Acquisition Professional, Tester, and Operator should be able to sit down at their desktop computer and be able to find out:

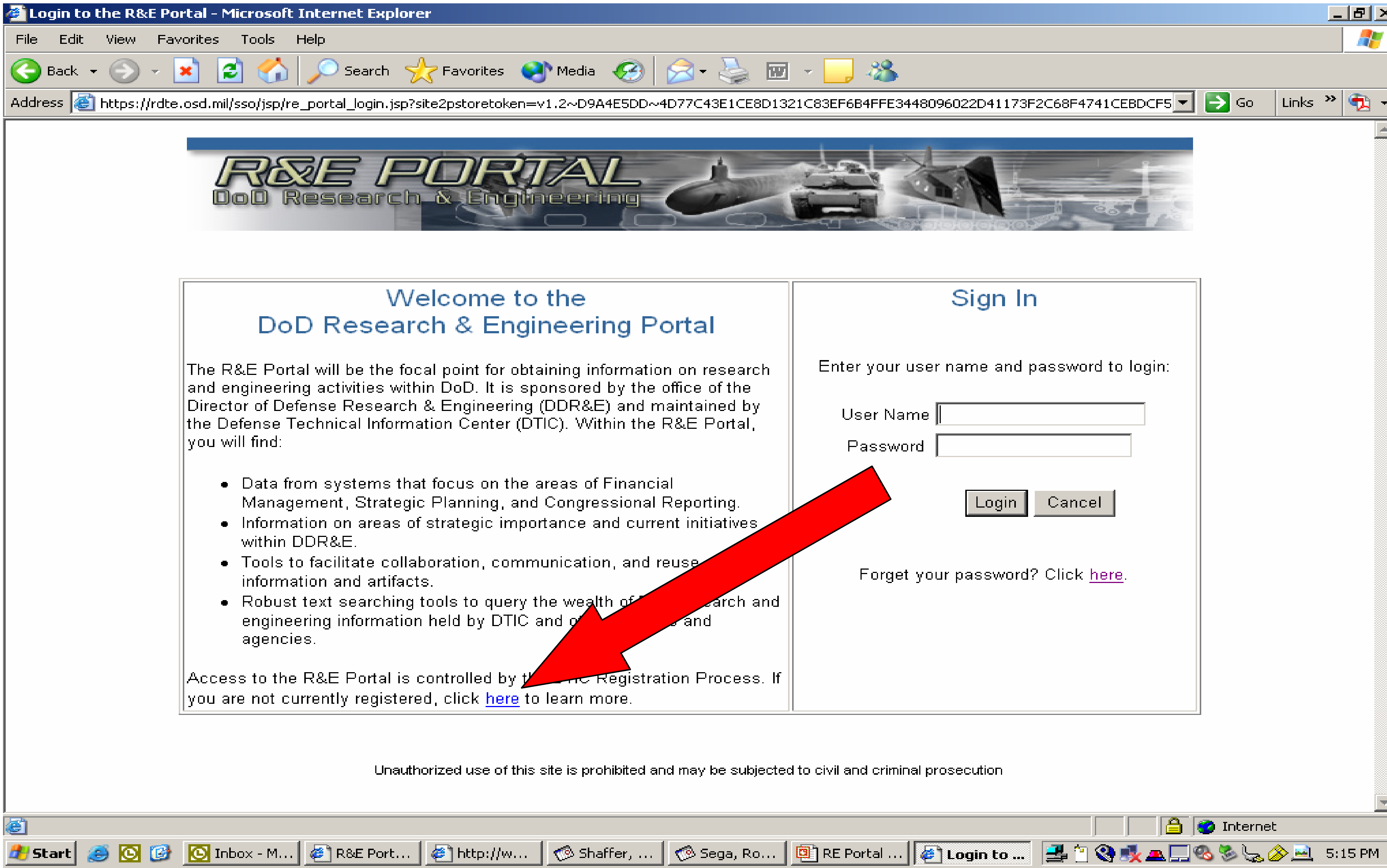
-- What the DoD is doing in R&E
-- Why we are doing the work
-- When the work will be done
-- Who knows more about this information

"Smarter Google" for the RDT&E and Warfighter Community

The R&E Portal
(https://rdte.osd.mil)

- Provide ***single-point access*** to:
  - All current R&E electronic information
  - New E-Gov database
  - R&E Points of Contact
  - News Service
  - DDR&E general information
  - Links to useful sites
- Be able to ***intelligently search*** all data
- Have ***Single sign-on capability*** (one password)
- Customer base: DoD R&E community (civil service, military, approved contractors)

(https://rdte.osd.mil)



R&E Portal Home Page - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address https://rdte.osd.mil/portal/page?_pageid=53,38931,53_38982:53_58493,53_40388&_dad=portal&_schema=PORTAL Go Links

R&E PORTAL
DoD Research & Engineering

Portal Home | R&E News | DDR&E Initiatives | E-Gov Initiative | Financial Management | S&T Planning Docs & Reports | R&E Communities

R&E Portal Updates

The Defense Technology Search now includes new libraries for the DTIC Research Summaries and the consolidated data from the E-Gov 2005 Data Call. Also added recently are libraries for the DTIC Technical Reports (TR), the Total Electronic Migration System (TEMS), and the Independent Research & Development (IR&D) database (restricted to DoD only).

2006 TARA Guidance documents are now available at the bottom of the S&T Comp Review page under S&T Planning Docs and Reports.

A Guide Through The Portal

DDR&E Initiatives

As the Chief Technology Officer for the Department of Defense, the DDR&E develops strategies to exploit technology

DDR&E Initiatives

New Tab

Announcements | Calendar | Forums

Files | Feedback | Help

Spotlight on R&E Success

A weekly article highlighting outstanding R&E Success Stories. These articles are randomly selected by DTIC from all Success Stories posted on DOD S&T Laboratory Web Sites.

DefenseLink Top News

SECURITY PATROL – U.S. Marine Corps Lance Cpl. Miez, a radio operator, and Cpl. Brad Adams, both with Lima Company, 3rd Battalion, 1st Marine Regiment, keep watch while on a security halt during a patrol down a riverbed in Barwana, Iraq, Jan. 15, 2006. U.S. Marine Corps photo by Cpl. Michael R. McMaugh Hi-Res Photo | Lead Photo Archive

Bush: Surveillance Plan Necessary, Lawful

WASHINGTON, Jan. 24, 2006 – President Bush yesterday called his terrorist surveillance plan a lawful, necessary step in the war against terrorism. Speaking at Kansas State University in Manhattan, Kan., Bush said he made the move to allow the National Security Agency to listen in on calls to terrorists as a means of protecting the American people. Story | Remarks

- Threats Must Be Taken Seriously, President Says

Industry Tapped for Ways to Counter IED Threat

WASHINGTON, Jan. 24, 2006 – Deputy Defense Secretary Gordon England called on what he called some of the best minds in the country today to help come up with new solutions to the threat improvised explosive devices pose to U.S. troops. Story

Department Sets Record With Charitable Giving

WASHINGTON, Jan. 24, 2006 – The Defense Department raised a record-high $15.1 million in the 2005 Combined Federal Campaign, exceeding the department's goal by $2.3 million Story

Piracy Incident Reflects International Problem

WASHINGTON, Jan. 24, 2006 – A U.S. Navy ship captured a suspected pirate vessel in the Indian Ocean about 54 miles off the coast of Somalia Jan. 21. Story | Suspected Pirates Captured Off Somali Coast

Info Is as Important as Ammo in 'Long War'

WASHINGTON, Jan. 24, 2006 – In the so-called "Long War," information will be as important as ammunition, U.S. Army Lt. Gen. Ray Odierno said. Story | Military Culture Must Change for 'Long War'

DDRE

Go to the DDR&E Website

Search DTS | Search Science.gov | Search Firstgov.gov | Search DDR&E | Search DefenseLink

Enter the DEFENSE TECHNOLOGY Search

Search digital libraries of comprehensive reports and data on DoD planned, ongoing and completed R&E efforts.

When prompted use your R&E Portal username and password. This will persist until you change your password or it expires. If your user password has changed since the last time you logged into the Defense Technology Search, click here to reset your password.

R&E Applications

- Biomedical Research Database
- Congressional Budget Queries
- DDR&E Applications Feedback Form
- Defense Science & Technology Planning
- Defense Technology Search
- IAC TEMS
- In-House S&T Activities Report
- Lab Demographics
- Militarily Critical Technologies List (Restricted)
- Private STINET
- RDT&E Budget Resource Queries
- Virtual Technology Expo

R&E Links

- AFIS Early Bird
- Advanced Concepts Technology Demonstrations
- Air Force Office of Scientific Research
- Army Research Office
- DefenseLink
- DefenseLink List of DoD Sites
- Defense Advanced Research Projects Agency
- Defense Technical Information Center
- DoD TechMatch
- Militarily Critical Technologies List
- Office of Technology Transition
- Office of Naval Research
- OUSD (AT&L)
- OSD Comparative Testing Office (CTO)
- National Aeronautics and Space Administration
- National Science Foundation
- Research & Development Descriptive Summaries
- Science.gov
- S&T Acquisition Workforce

Personal Favorites

Local intranet

Summary

- **PB08 request is lower than the PB07 request but still represents a solid investment compared to historical averages**
  - **Current S&T program is still strong**
  - **Investment increased in QDR-highlighted capabilities**
- **Cautionary notes**
  - **OSD generally up more than Services; Services are less than 50% of total S&T budget**
  - **Workforce of the future remains an issue**
  - **Impact of Services activity in Iraq and Afghanistan limits discretionary programs**

Responsive Space Technology

The NDIA 8th Annual Science & Engineering Technology Conference/DoD Tech Expo

Tuesday, 17 April 2007

Dr. Robert Morris
Chief Scientist (acting)
Air Force Research Laboratory
Space Vehicles Directorate

Outline

- ORS Overview
- ORS S&T Strategy
- Demonstrations through TacSats

Congressional Direction on ORS Program Office (H.R. 5122-07)

- The SECDEF shall establish within the DOD an ORS Program Office
- Mission of the Office shall be to contribute to the development of low-cost, rapid reaction payloads, spacelift, and launch control capabilities in order to fulfill joint military operational requirements for on-demand space support or reconstitution
- Office Elements
  – S&T Division
  – Acquisition Division
  – Ops Division
  – Combatant Command Support Division
- Cost caps on ORS systems (as practicable)
  – $20M per launch
  – $40M per spacecraft
- 120 days for report back to Congress

Mission and Tasks

- **Mission**
  - **Develop desired ORS capabilities/characteristics, advocate, plan, and conduct space ops**

- **Tasks**
  - **<u>Reconstitute</u> lost capabilities**
  - **<u>Augment/Surge</u> existing capabilities**
  - **<u>Fill Unanticipated Gaps</u> in capabilities**
  - **<u>Exploit</u> new technical/operational innovations**
  - **<u>Respond</u> to unforeseen or episodic events**
  - **<u>Enhance</u> survivability and deterrence**

Tiered Approach

Tier-1) On-demand with existing assets *(minutes/hours)*
Employ It

Tier-2) On-call with ready-to-field assets *(days/weeks)*
Launch It / Deploy It

Capability Already Available

Tier-3) Emergent with rapid transition from development to delivery of new or modified capabilities *(months)*

Develop It

Capability Does Not Exist

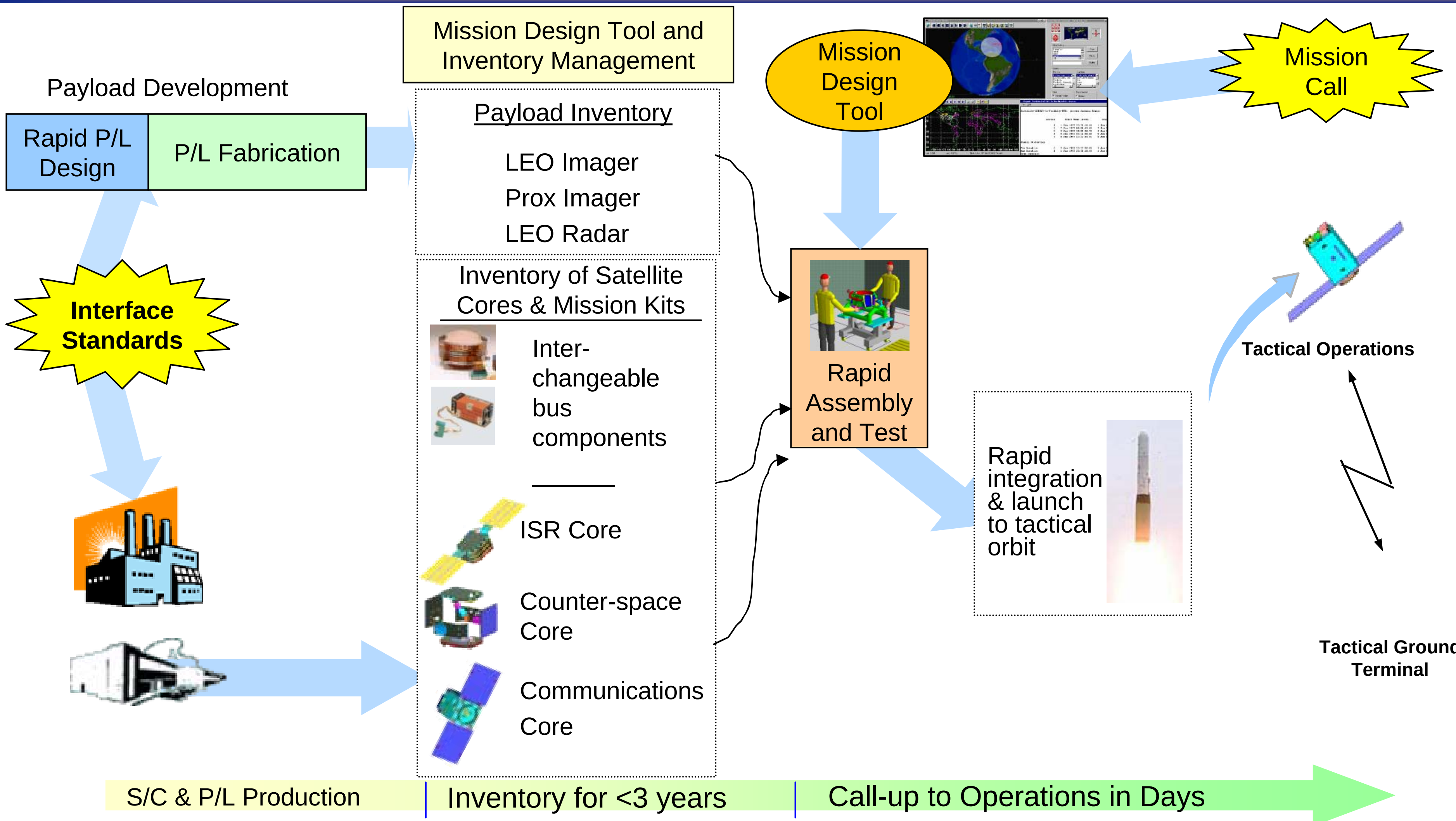
Deliver Space Effects in Response to an Urgent Need

Development Strategy

1. Develop Robust S&T Portfolio
   - Address core S&T shortfalls/barriers
   - Develop a modular, plug-n-play bus to lower cost & development time
   - Adapt existing technologies (plug-n-play, aircraft sensors, COTS electronics, etc…) for small, low-cost satellites
   - Develop integrated software suite covering entire range of needs from mission planning to autonomous, on-orbit checkout and ops
2. Conduct Operational Experimentation (TacSat Experiments)
   - Testbed to validate S&T, CONOPS, and military utility
   - Warfighter CONOPS Experiments
     – Explore the military utility of small, low-cost satellites
     – Develop methods for theater tasking/data dissemination
     – Service or CoCom partner
   - Prototype of an operational system
3. Develop Innovative Acquisition Methods
   - Rapidly acquire these systems if they are useful

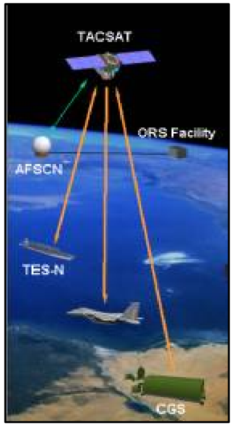
Strategy Links Technologists & Warfighters in Operational Experiments

RSATs Responsive Space Vision

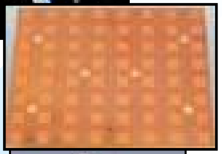


The S&T Foundation Enabling USSTRATCOM ConOps

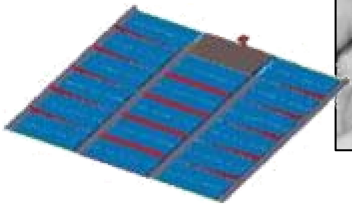
Responsive Satellite Enabling Technology



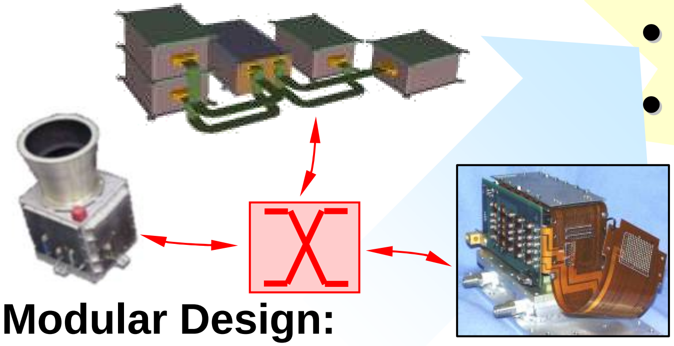
- **Tactical Operations and Data Dissemination:**
  - **Integrate with existing ISR C2 (e.g. Space CDL, UHF, JTRS, GBS)**
  - **Must fit into existing warfighting architecture**
  - **Provide decision quality data to the warfighter**



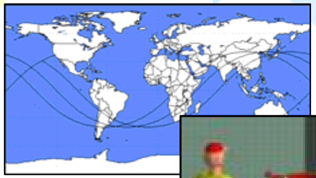
- **Advanced Small / Microsat Technologies:**
  - **Lightweight, low cost apertures**
  - **Advanced power**
  - **Efficient propulsion**
  - **Low cost rad-tolerant components**



- Responsive
- Affordable
- Employable
- Integrated



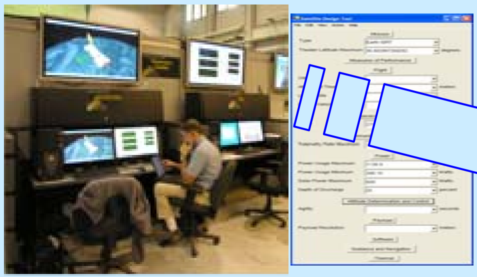
- **Modular Design:**
  - **Plug 'n play architecture**
  - **Standard, open architecture interfaces**



- **Rapid Deployment & Ops:**
  - **Mission planning tools / tailored orbits**
  - **Fast assembly and test**
  - **Rapid autonomous deployment and operations**

Investments Being Made Across DoD S&T Enterprise

Responsive Satellite Test Bed
Where the Vision is Translated into Products

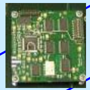


Satellite Design Toolkit

Adaptive Wiring Manifold

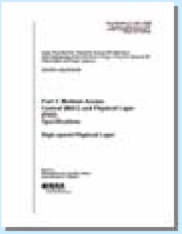
Rapid Assembly and Test

•Star Tracker
•Structure
•C&DH
•Core Bus



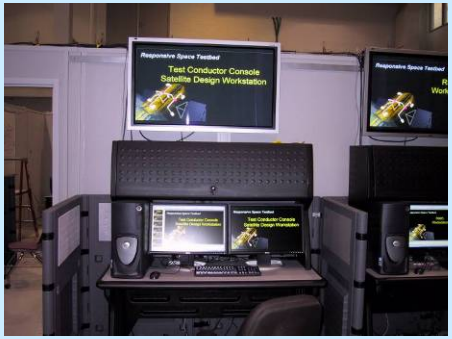
ASIM
(Applique Sensor Interface Module)

Responsive Technology Cell

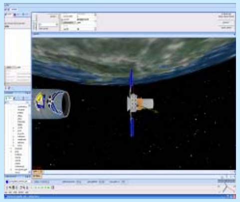


SPA-U
SPA-S
SPA-E
XTEDS –
(Electronically Readable Datasheets)

Satellite Data Model S/W & Guidebook



RIMS Ground Station



Hardware-in-Loop Test Bed with Full 6DOF Physics Simulation

<u>2005-6 Experiments</u>

- **Push Button Tool Flow Mission Planning**
- **Full Plug-n-Play integration**
- **Elimination of written ICD's with XTEDS**
- **Adaptive Wiring Manifold**
- **Autogenerated spacecraft flight s/w**
- **Sub-real/real/super-real flight simulation**
- **<u>2 hour spacecraft assembly !</u>**

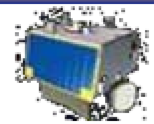
<u>2006 – 2007 Objective</u>

•Creation of first p-n-p modular bus

The Existence Proof of the Modular Plug-n-Play Satellite

Operational Experimentation

- UK TopSat
  - **Conducting operational experiments with UK's low cost imaging spacecraft on orbit, delivered imagery to warfighter < 90 minutes via internet**

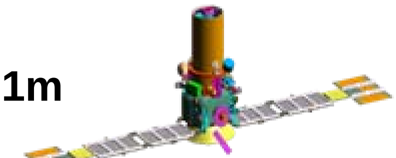


TopSat

- TacSat-1 **(Lead: NRL for OSD/OFT)**
  - **Dual-mode target identification using Specific Emitter Intelligence (SEI)**
  - **Estimated launch April 07 Space-X Falcon-I**

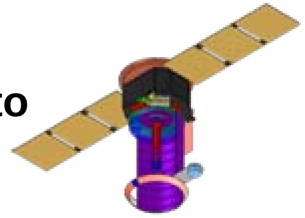
TacSat-1

- TacSat-2 **(Lead: AFRL/VS)**
  - **Provides enhanced SEI & Automatic Identification Systems and ~1m resolution imagery, tactical tasking & data dissemination**
  - **Launched 16 Dec 2006**



TacSat-2

- TacSat-3 **(Lead: AFRL/VS)**
  - **Hyperspectral and panchromatic imagery directly to tactical user or to CONUS data center, On-board data processing**
  - **Estimated launch Fall 2007**



TacSat-3

- TacSat-4 **(Lead: NRL)**
  - **"Comm on the Move", Data Exfiltration and Blue Force tracking**
  - **Launch ready 2008**

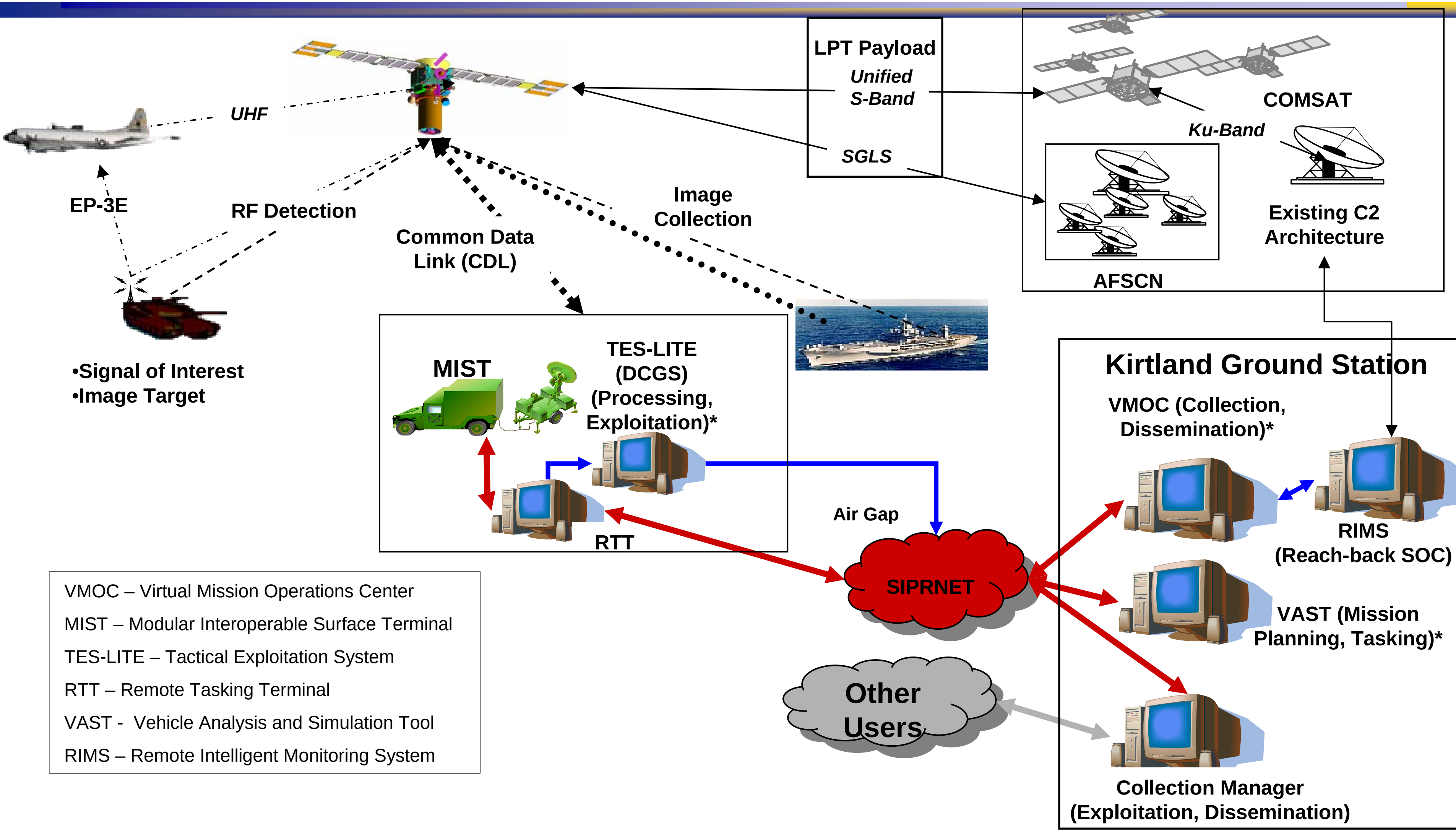
TacSat-4

- TacSat-5 **(Lead: TBD)**
  - **Initiated TacSat-5 Selection Process – 27 July 2006**

TacSat-2 Description

- Primary Payloads:
  - 50-cm imaging telescope (line scanner array, PAN, 3-color)
  - Specific Emitter Identification (SEI) radio and Automated Identification System (AIS) receiver
- Spacecraft Mass: 368 kg
- Spacecraft Power:
  - ~550 Watts, triple junction cells
  - 60 Watt experimental thin film PV Arrays
- Orbit: 410 km, 40º inclination
- Mission Life
  - 6 month threshold, 1 year goal
- Mission Objectives
  - Assess military utility of low-cost ISR satellites & ground stations
  - Evaluate concepts for simplifying and expanding warfighter access to space assets
  - Demonstrate concepts for faster acquisition, responsive launch & operations
- MUA led by AFSPC SIDC –
  - Exercises: Talisman Sabre, Coalition Warrior

TacSat-2 CONOPS



VMOC – Virtual Mission Operations Center

MIST – Modular Interoperable Surface Terminal

TES-LITE – Tactical Exploitation System

RTT – Remote Tasking Terminal

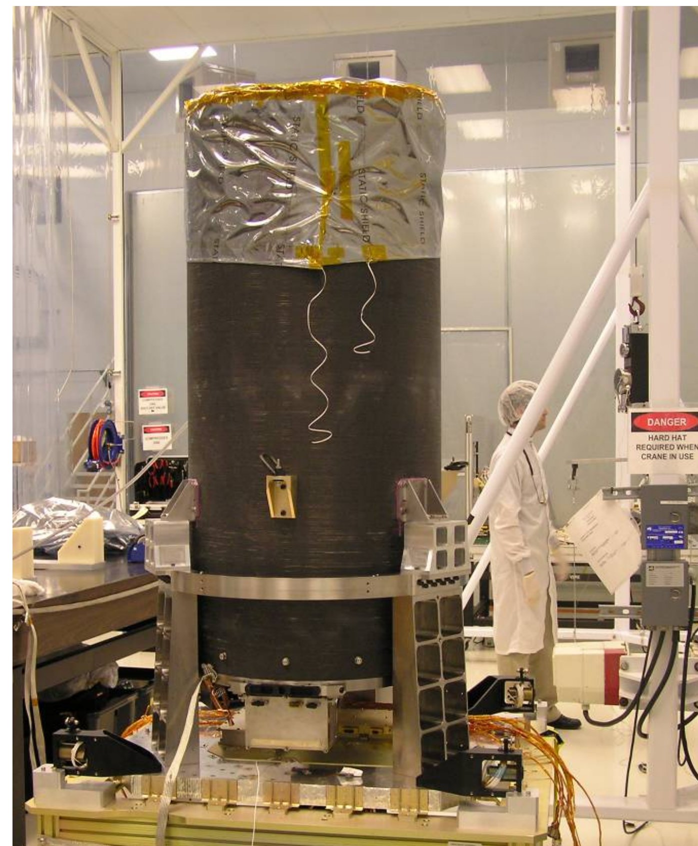
VAST - Vehicle Analysis and Simulation Tool

RIMS – Remote Intelligent Monitoring System

TacSat-2 provides theater and CONUS tasking/dissemination options

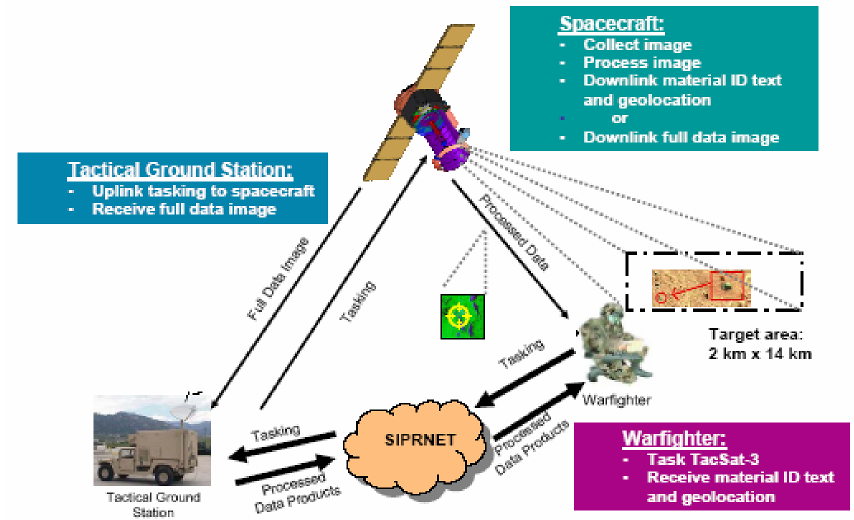
TacSat-2 Imager

- **Enhanced commercial imager, comprised of a 20-inch telescope with four-color line scanner, demonstrates low-cost space imagery**



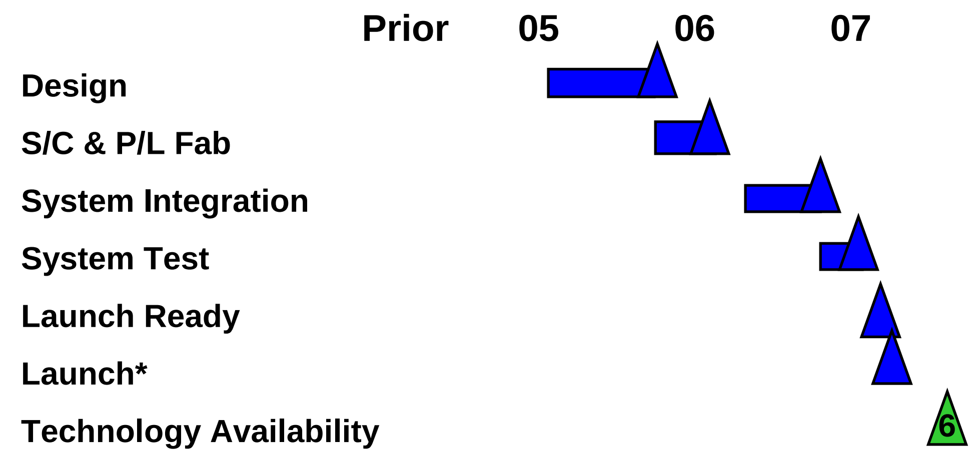
- **Capabilities**
  - **5 kilometer image width with variable length**
  - **Panchromatic, red, blue and green images; 3.9 – 5 kilometers image width**
  - **Best expected ground sampling distance of 0.84 meters**
  - **Ground processing required to construct multispectral images**

TacSat-3



Space capabilities delivered directly to the operational and tactical warfighter

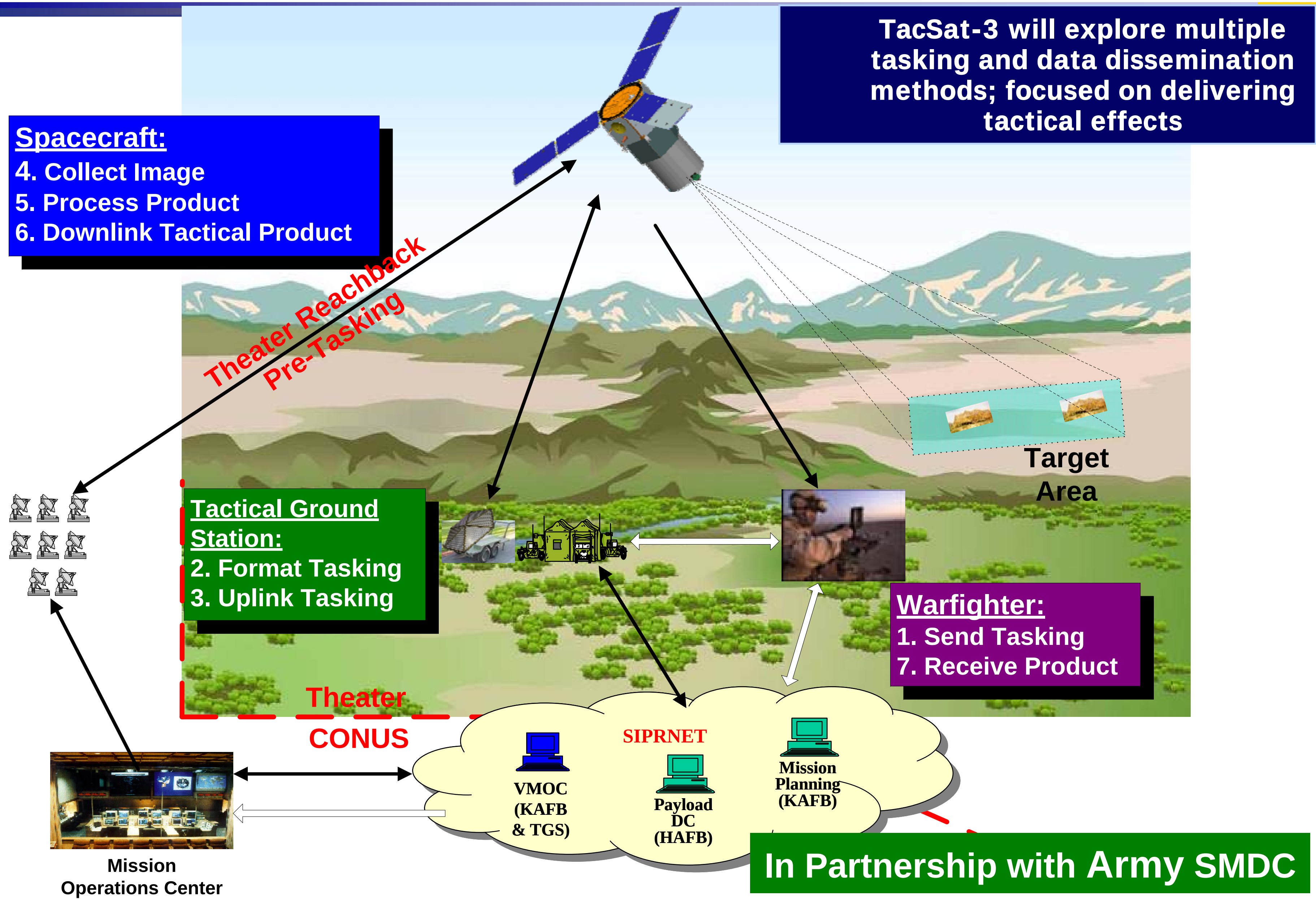
Technology Investment Schedule (FY)   As of 19 Oct 05



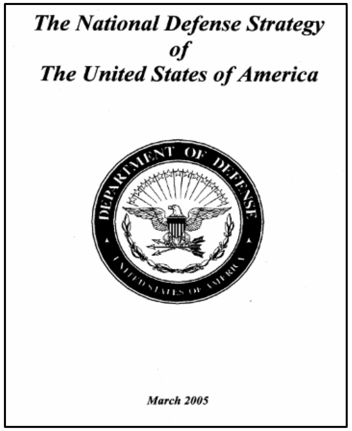
***Current Launch Date October 07**

Description	Benefits to the War Fighter
Integration of technologies demonstrating new capabilities in responsiveness, mission ops, modularity of spacecraft design, low-cost payload development, & advanced modularity experiment	• Hyperspectral imaging products • Next generation “Plug and Play” spacecraft • Enable rapid launch within 7 days from alert status. • Responsive Theater Communications: -Near-real time (< 10 min) delivery of decision quality data • Low cost implementation of an objective system • Data exfiltration from unattended ocean buoys
Critical Experiment	
• Hyperspectral and panchromatic imager • Data exfiltration payload • Wideband and narrowband in theater comm. • Small spacecraft <400 kg • Partnerships with Army and Navy	

TacSat-3 CONOPS
Tactical Ops – Real Time Downlink & C2



Conclusions


The National Defense Strategy of The United States of America

March 2005

"Uncertainty is the defining characteristic of today's strategic environment… we must posture ourselves to handle unanticipated problems – we must plan with surprise in mind"

- **Developing a radical approach to bring space capabilities to the tactical level of war**
- **Investing in the necessary S&T**
  - **Modular 'plug-n-play' satellite bus**
  - **High performance tactical downlinks**
  - **Adaptable, agile propulsion systems**
  - **Lean fab, assembly, test, ops**
- **Space demonstrations LEARNING BY DOING!**

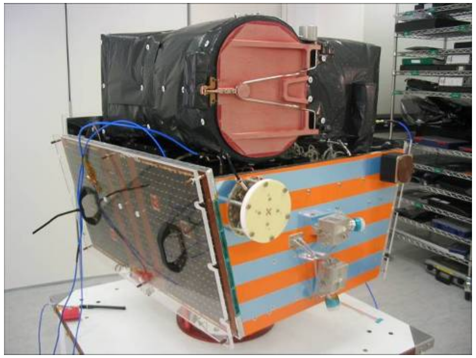
Discovering and Developing New Technologies & Delivering Important New Capabilities

Backups

UK TopSat

- Design Goals
  - Cost £14M / $23.4M DESIGN GOALS
  - Small (~100kg/ 218 lbs mass)
  - Ground spatial resolution (on-nadir)
    - 2.8m (b&w)
    - 5.6m (colour)
  - Images 17km x 17km (b&w)
    - 10km x 17km (colour)
    - Max 4 each/day
  - FoR +/-30 deg
  - TDI x4
  - Global revisit once every 3 days
  - Imagery downloadable to mobile ground station
  - Lifetime >1 year
- STATUS
  - Launched 27th Oct 2005
  - Altitude 686km SS
  - FoV = 17km
  - X4 TDI
  - Ground spatial resolution (on-nadir)
    - 2.8m (b&w)
    - 5.6m (colour)
  - S-Band and X-Band downlink to fixed UK Ground Station confirmed
  - Successful download of imagery to RAPIDS mobile ground station demonstrated

London,12/2005



TacSat-1

- Launch Ready
  - Current launch date ~Feb 07
- MicroSatellite:
  - 125 kg, 186 W
  - 40 in dia. x 20 in high
  - 510 km, 64º inclination
  - 1 year life

- Payloads:
  - Cross-platform RF Collection and Specific Emitter Identification
  - Visible (70m) & IR (850m) Imaging

- CONOPS Highlights:

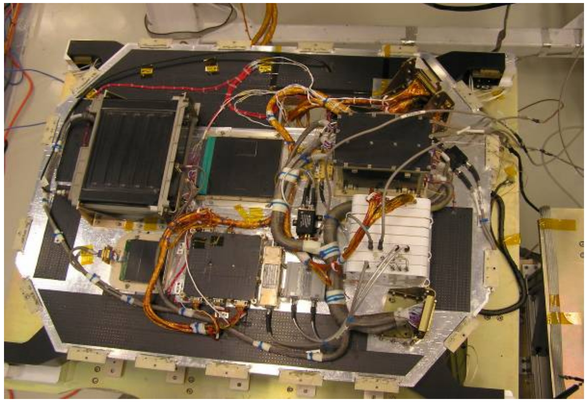
1) Cross-Platform RF collection & geolocation using TacSat-1 and EP-3
2) Specific Emitter Identification experimentation
3) SIPRNET web site for payload scheduling (tasking requests), data access, and collaboration

- Imagers installed primarily from this SIPRNET CONOP & user interface experimentation
- Net-centric TTP's, CONOPS, and behavior analysis (e.g. self-organizing scheduling)

- Ground station: Blossom Point MD
  - With VMOC (Virtual Mission Operations Center) for SIPRNET tasking, data assess, & collaboration
  - Addition AFSCN Antenna Coverage

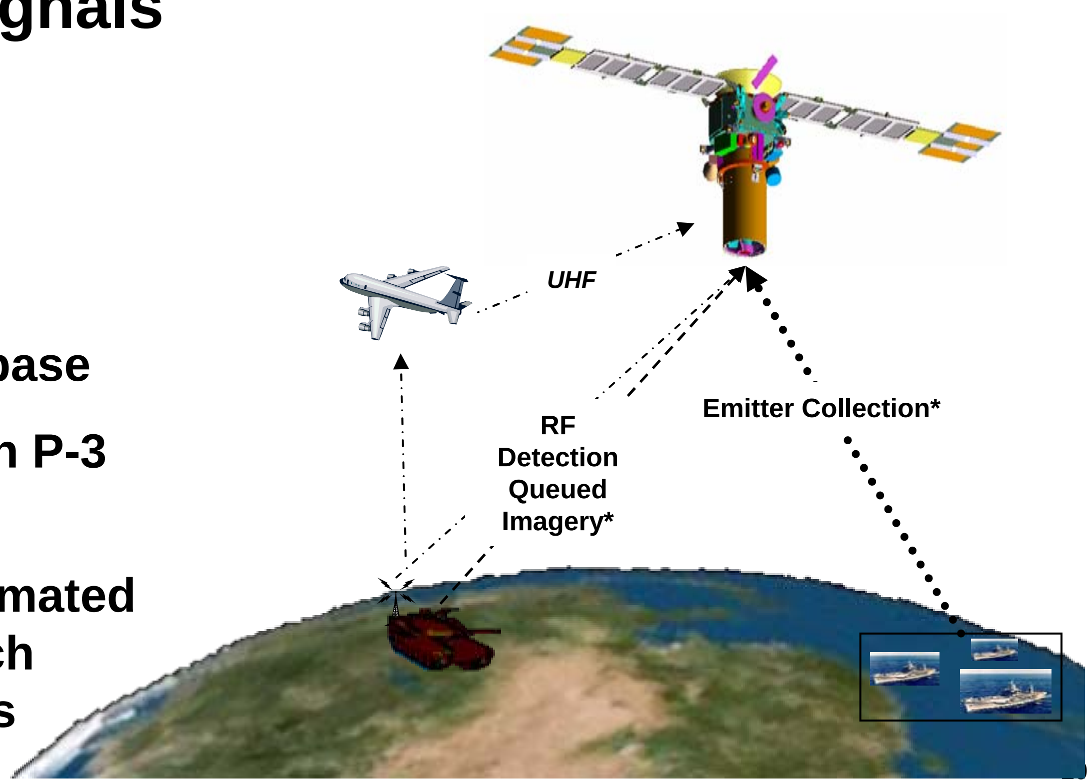
- Aircraft:
  - EP-3s: 1 fixed and 3 mobile RORO units
  - RJs expected but number TBD
    - "Arctic Lab" testing performed fall 2004

TacSat-2 TIE Payload

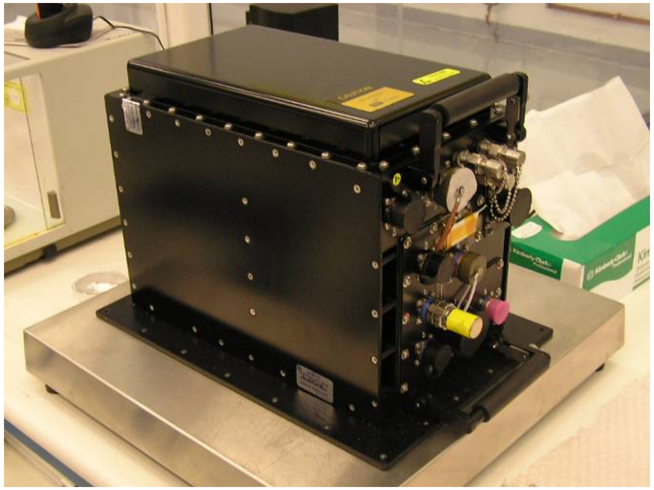


- **U.S. Navy's Target Indicator Experiment (TIE) consists of a wideband sensor to collect radar, radio, and handheld communication signals**

- **Capabilities**
  - **Radio frequency emitter detection**
  - **Signal ID by onboard database**
  - **Geolocation in concert with P-3 and Rivet Joint**
  - **Demonstration of the Automated Identification System, which tracks ocean-going vessels**



TacSat-2 CDL Radio

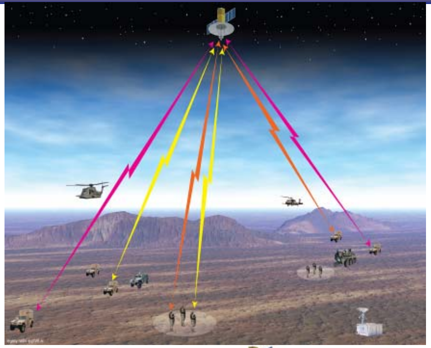


- **Common Data Link (CDL) tactical radio transmits imagery and communication data to the Modular Interoperable Surface Terminal (MIST), at the U.S. Navy's China Lake, Calif., facility.**

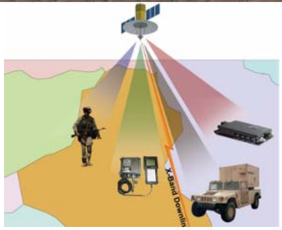
- **Capabilities**
  - **Command uplink and data downlink accomplished by the apparatus**
    - ❖ **High transmission rate of 6 X 42.8 megabytes per second**
    - ❖ **Low broadcast speed of 10.8 megabytes per second**
  - **MIST ground station is an operational Army system**
    - ❖ **Both uplink and downlink verified with the spacecraft**

TacSat-4

Capability Gaps/Shortfalls Satisfied



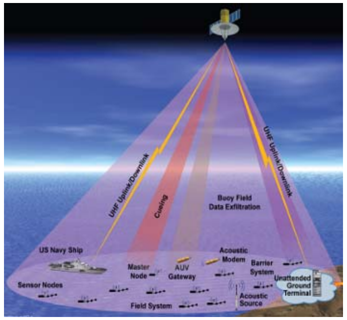
- Comms On the Move
  - A. Beyond Line of Site (BLOS) UHF Comms Legacy Radios
    - **Voice: 50-100 Users; Data: 20 Users**
  - **B. BLOS IP Networked Comms Using Legacy UHF Radios**
    - **Network Users: 40-60 w/ 16 kbps Radio; 320-640 w/ 56 kbps Mode**
    - **Allows Configurable Comms: Point-to-Point Comm and Multi-cast**
    - **Supports BLOS C2PC and FBCB2 Networking**
  - **C. MUOS-Like Wideband Comms (256 kbps per user)**
    - **Wideband Allows 100's-1000 Users Per Channel**
    - **Early Testing and Augmentation with MUOS-Like Comms**



- Blue Force Tracking (UHF BFT)
  - **Collect Existing UHF BFT Devices in Underserved Areas (>10,000 Units)**
  - **Route Data via Existing Channels**
  - **Augment NTM in Underserved Areas**
- Data-X
  - **Data Exfiltration from Buoys & Unattended Ground Sensors**
  - **Collects Sensors > 1 Watt**
  - **Allows Direct-to-Ship Collection**

White-Paper Capabilitiy Gaps/ Shortfalls Satisfied			
Service / Mission	COTM	BFSA	Data-X
Army	X		
Navy			X
Air Force			
Marines	X	X	
Strat/SOF	X	X	

Features



- **One Ground Terminal Required per 4000 nm Theater**
- **Near Global Collection Capability**
- **No User Antenna Pointing Required**

Launch Ready Mid 2008

An Industry View

LOCKHEED MARTIN

What Are We Going To Talk About

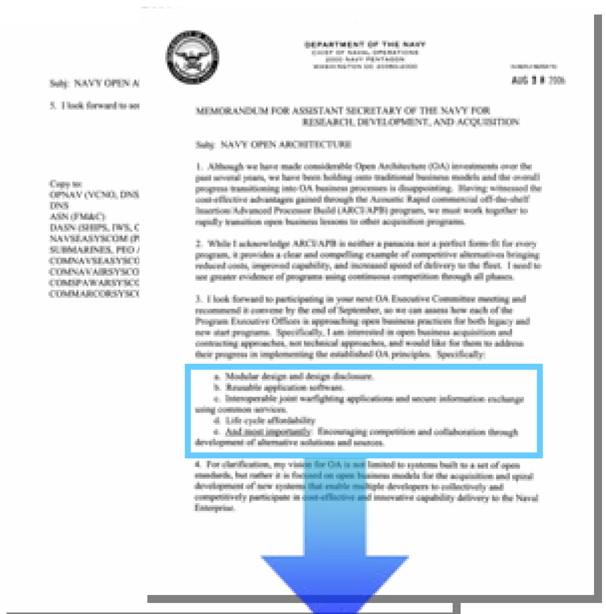
- **Preamble**
  - – Understanding each other
  - – Open Architecture – An Imperative
- **What the Navy Defines as Open Architecture**
  - – Core Principles
  - – Technical Conditions for OA Business Practices
- **Concept of a “Systems Integrator”**
  - – ARCI and SWFTS
  - – Systems Integrator vs. Capability Provider
- **What a Notional Business Model Looks like**
  - – Who is responsible for functions
  - – Role of Competition and Innovation
- **Perceptions, Challenges, and DoD Policy**
- **Conclusions**

Preamble

- **Open Architecture means many things to many people in both industry and Government**
  - **Technical Perspective**
    - Hardware v. Software
    - Modularity
    - Standards
  - **Business Process Perspective**
    - Competition
    - Best of Breed
    - Small Business based innovation

- **OA is really about providing warfighting capability in a Network Centric Environment**
  - **OA is critical to the timely upgrade of <u>combat capabilities</u> – systems that meet Navy missions**
  - **Affordability is an important *element*, but not the only *driver***

Navy OA Enterprise Vision



DEPARTMENT OF THE NAVY

MEMORANDUM FOR ASSISTANT SECRETARY OF THE NAVY FOR RESEARCH, DEVELOPMENT, AND ACQUISITION

Subj: NAVY OPEN ARCHITECTURE

1. Although we have made considerable Open Architecture (OA) investments over the past several years, we have been holding onto traditional business models and the overall progress transitioning into OA business processes is disappointing. Having witnessed the cost-effective advantages gained through the Acoustic Rapid commercial off-the-shelf Insertion/Advanced Processor Build (ARCI/APB) program, we must work together to rapidly transition open business lessons to other acquisition programs.

2. While I acknowledge ARCI/APB is neither a panacea nor a perfect form-fit for every program, it provides a clear and compelling example of competitive alternatives bringing reduced costs, improved capability, and increased speed of delivery to the fleet. I need to see greater evidence of programs using continuous competition through all phases.

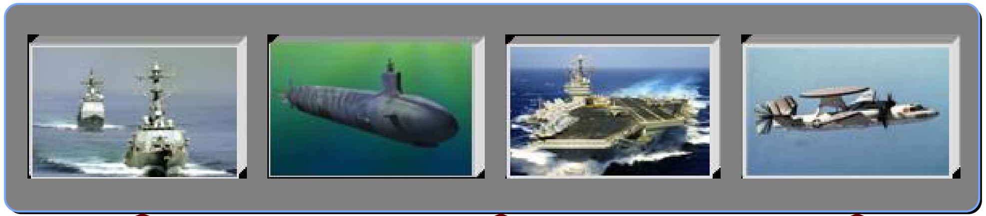
3. I look forward to participating in your next OA Executive Committee meeting and recommend it convene by the end of September, so we can assess how each of the Program Executive Offices is approaching open business practices for both legacy and new start programs. Specifically, I am interested in open business acquisition and contracting approaches, not technical approaches, and would like for them to address their progress in implementing the established OA principles. Specifically:

a. Modular design and design disclosure.
b. Reusable application software.
c. Interoperable joint warfighting applications and secure information exchange using common services.
d. Life cycle affordability
e. And most importantly: Encouraging competition and collaboration through development of alternative solutions and sources.

4. For clarification, my vision for OA is not limited to systems built to a set of open standards, but rather it is focused on open business models for the acquisition and spiral development of new systems that enable multiple developers to collectively and competitively participate in cost-effective and innovative capability delivery to the Naval Enterprise.

Copy to:
OPNAV (VCNO), DNS
DNS
ASN (FM&C)

Core Navy OA Principles



Common Computing Environment + Common Platform Functions + Platform Unique Functions

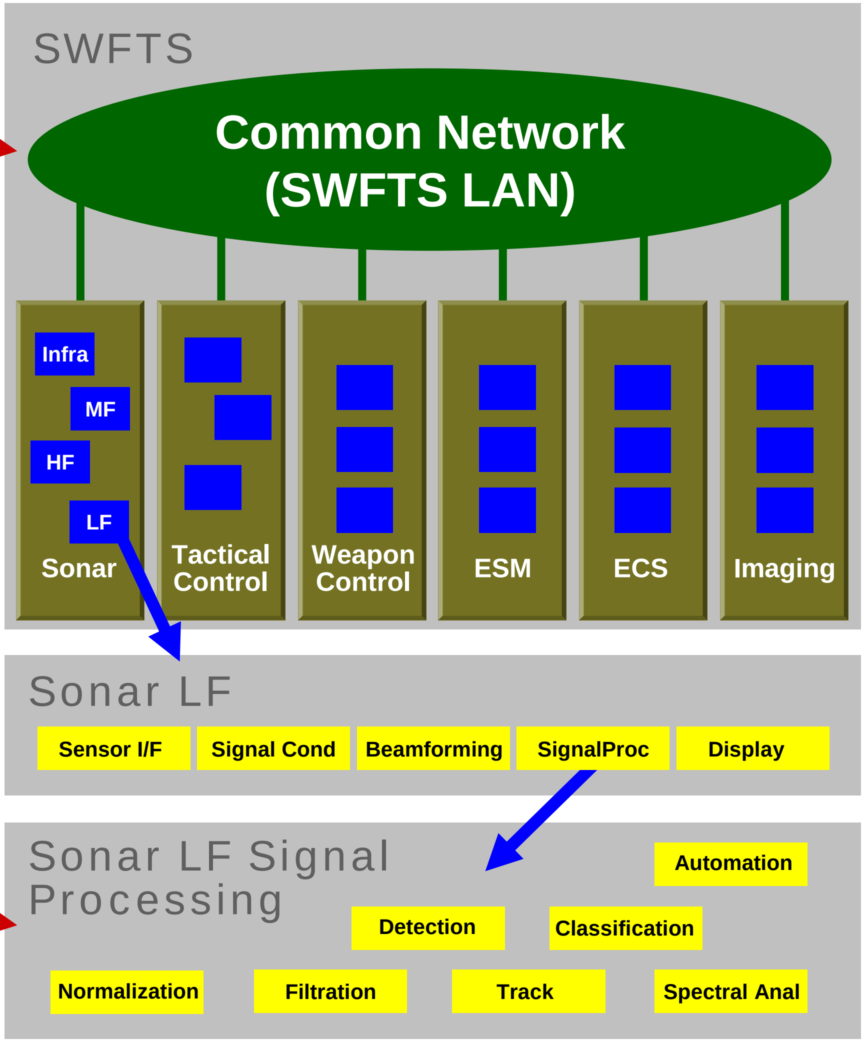
Common Joint Architecture

- *Modular designs*
- *Reusable application software*
- *Interoperability joint warfighting applications*
- *Life Cycle Affordability*
- *Encouraging collaboration and competition*

Necessary Pre-Condition– Break Software Dependence on Hardware

ARCI – Successful OA Model

- System Engineer and Integrator



- Robust Competition for Component Development

Supports Both Operational and Business Objectives

Systems Integrator

Three Responsibilities:

- **Systems Engineer and Design Agent**
  - Manage Architectural Definition/Evolution
  - Software segment interface coordination
  - Technical Gap Identification
  - Requirements decomposition and allocation
- **Facilitate Competitive Development Environment**
  - Development infrastructure
  - Peer Review Operation Support
- **Integrate “Best of Breed” Elements into System**
  - Life Cycle Configuration Management
  - Element, Directed, and Operational Test Support
  - Technical Support to the End User

“Best of Breed” Decision - Inherently Governmental Responsibility

Business Model – Industry Perspective

Identify and Define
- Capability Request
- New Requirement
- Operational Need

Government Led
- New Threat
- Improved Performance
- New Mission
- Technology evolution
- CONOPS

Engineering Refinement
- Correlate need to system element(s)
- Characterize need with technical rigor
- Identify gaps in technology

Industry Led
Systems Engineer / Design Agent

Advertise Need and Focus S&T
- Identify potential solutions
- Assess technical and schedule risks
- Focus investment
- Stimulate innovation

Government Led
- Invest in S&T
- Engage Academia
- Leverage Govt Labs
- Pulse industry (BAA)
- Experimentation
- ACTD/ACD
- SBIR

Government – Industry Team

Advanced Processor Build (APB)

Industry Led
Systems Integrator

Trial X Testing

System Integration

Assessment

Technology Evaluation
- Build and Test

PEER REVIEW

Government Led
Government Decision

Industry Managed
Systems Engineer / Design Agent
Collaborative Environment

Common (Mis)Perceptions

Systems Integrator must be excluded from participation in development efforts – Unfair in competitive environment

- Government leadership in Peer Review Process and Selection isolates SI from undue influence
- Exclusion potentially eliminates “Best of Breed, Best Value” Options
- Inhibits “Free Market” Access
- Competition for development work is the foundation of SI domain expertise

Common (Mis)Perceptions (Continued)

- **Maximum "Reuse" of Components is a Leading Driver**
  - Sensible "Reuse" is important, but ***"Common"*** is better
    - Reuse still requires maintenance in each separate instantiation
    - Common processing provides common results - SIAP
  - Conditions should be considered
    - Where the Math Matters!
    - Large populations of Systems need the same functions and capabilities
    - Only if cost benefit is positive
      - Don't replace existing adequate functions

- **Government Owns the Source Code and/or has Unlimited Rights if Components are produced under a Government NRE Contract**
  - Process must meet conditions of a "Free Market"
  - Most Development Efforts include Industry Owned Intellectual Property
    - Fair Market construct must be available to recognize IP
  - Industry must Recognize Government Ownership for its Contribution

Common (Mis)Perceptions (Continued)

- **Third Party Content is a Measure of How Open A System Is**
  - Metric should be how **quickly and affordably** a system can take third party content
  - Third party content in any particular system is dependent upon:
    - How and when the system was originally developed
    - Capability upgrade requirements
    - Degree to which OA business practices have been developed and applied

- **OA Systems are, by definition, "Plug and Play"**
  - Modularity that allows for straight forward integration **does** reduce interface complexity and testing to a significant degree, but…
  - Completely clean "plug and play" is not reasonably achievable
    - Interdependence of components not perfectly definable at interfaces
    - Systems that provide dynamic weapons control or ordnance delivery require exacting verification of functionality

Conclusions

- Industry has been listening to the U.S. Navy regarding its desire to move aggressively into OA.
  - Supported OA transformation of "capital ship" combat systems into modern OA CAT 3 condition
  - Working with the USN to define the business models and practices required to take advantage of this transformation
  - Ready to move out, however……

- Industry cannot follow the USN into waters that do not have sufficient "free market" draft to make them navigable.
  - Loss of market space controlled by system boundary, means aperture must be opened to competition across all software based systems
  - Must strike the right balance between Government Rights and Industry IP
    - US Government must recognize the value of IP, particularly to small business
    - Acquisition policy that provides sufficient depth for all to sail

- Establishing the business model and putting the mechanisms in place to make it go, are essential for the USN to receive full benefit of its OA investment.
  - Technical is necessary, but it's not sufficient
  - Process will produce only what it is designed to produce – won't get different results without process change

OA is About Providing Capability … Quickly and Affordably

NORTHROP GRUMMAN

DEFINING THE FUTURE

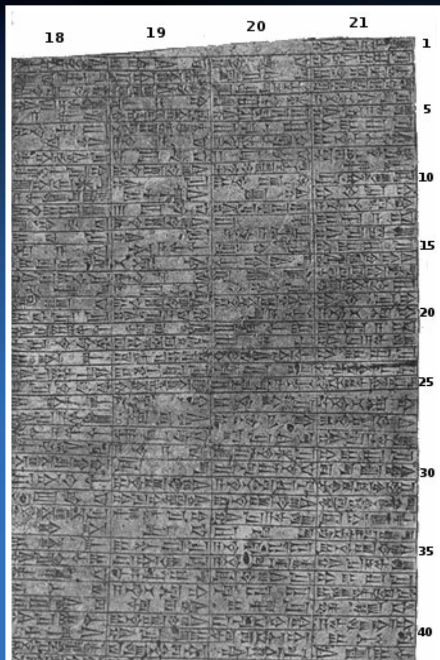
NDIA
THE 8th ANNUAL SCIENCE & ENGINEERING TECHNOLOGY CONFERENCE / DoD TECH EXPO

Air Force Space Systems for Transformation

Date April 14-17, 2007

Stuart Linsky
Vice President, Satellites Communications
Northrop Grumman Space Technology

Challenges in balancing performance and risk



<u>Hammurabi's Code</u>

- **282 laws**
- **1760 BC**

229. ***If a builder build a house for some one, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death.***
230. ***If it kill the son of the owner the son of that builder shall be put to death.***

Causes of Engineering Disasters

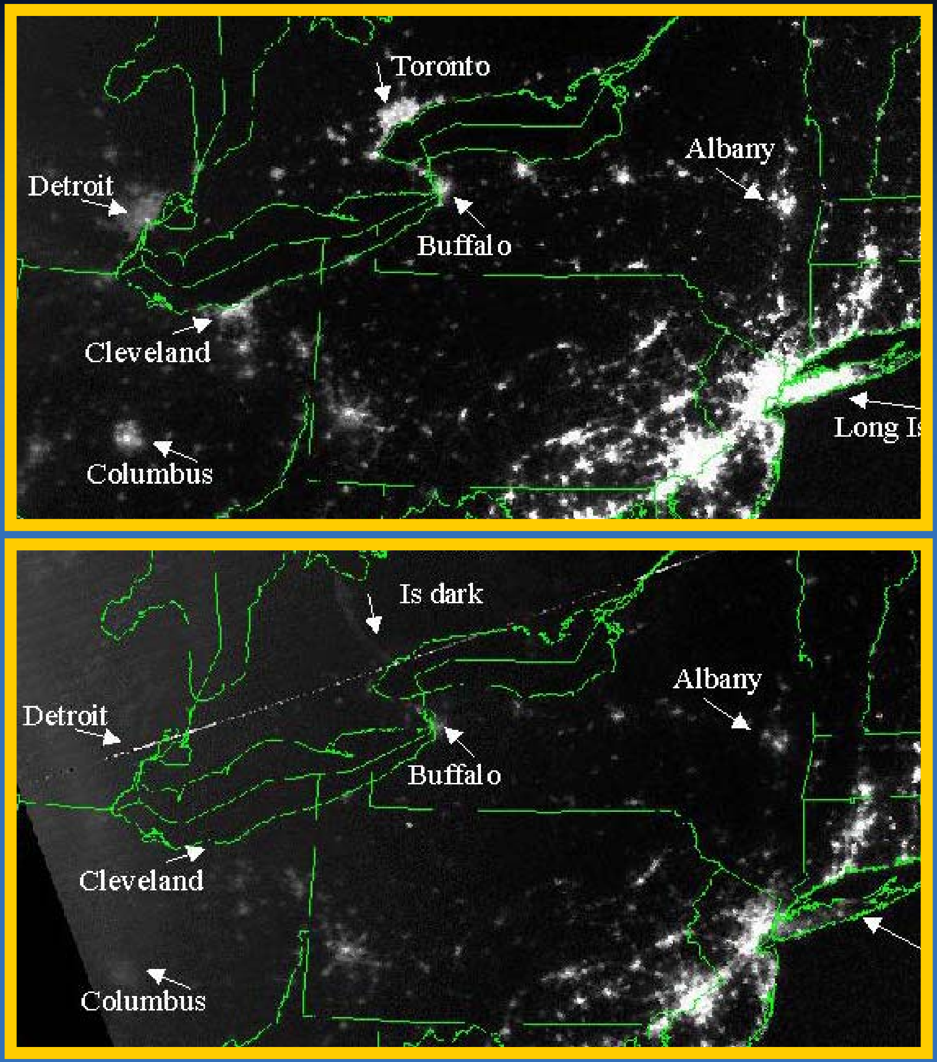
• Insufficient knowledge	36%
• Underestimation of influence	16%
• Ignorance, carelessness, negligence	14%
• Forgetfulness, error	13%
• Relying upon others without sufficient control	9%
• Objectively unknown situation	7%
• Imprecise definition of responsibilities	1%
• Choice of bad quality	1%
• Other	3%

* Study by Swiss federal Institute of technology in Zurich

• Funding instability	~ 36 %
• Initial program parameters not reasonable	24 %
• Technology below best practice maturity standards	18 %
• Requirements instability	13 %
• Staffing problems	8 %
• Excessive oversight	7 %
• Inexperienced leadership	7 %

*GAO question DOD's major weapon program managers

Certain Failures are Unacceptable



*CBC News Online | August 15, 2003, Updated November 14, 2003

Blackout by the Numbers

- 9sec - Time it took for the grid to collapse
- 6M - Area affected in acres
- 50M - Number of people affected
- 100 - Power plants shut down
- 22 - Nuclear power plants shut down
- 31C - Expected daytime high in Ontario

<u>New York</u>

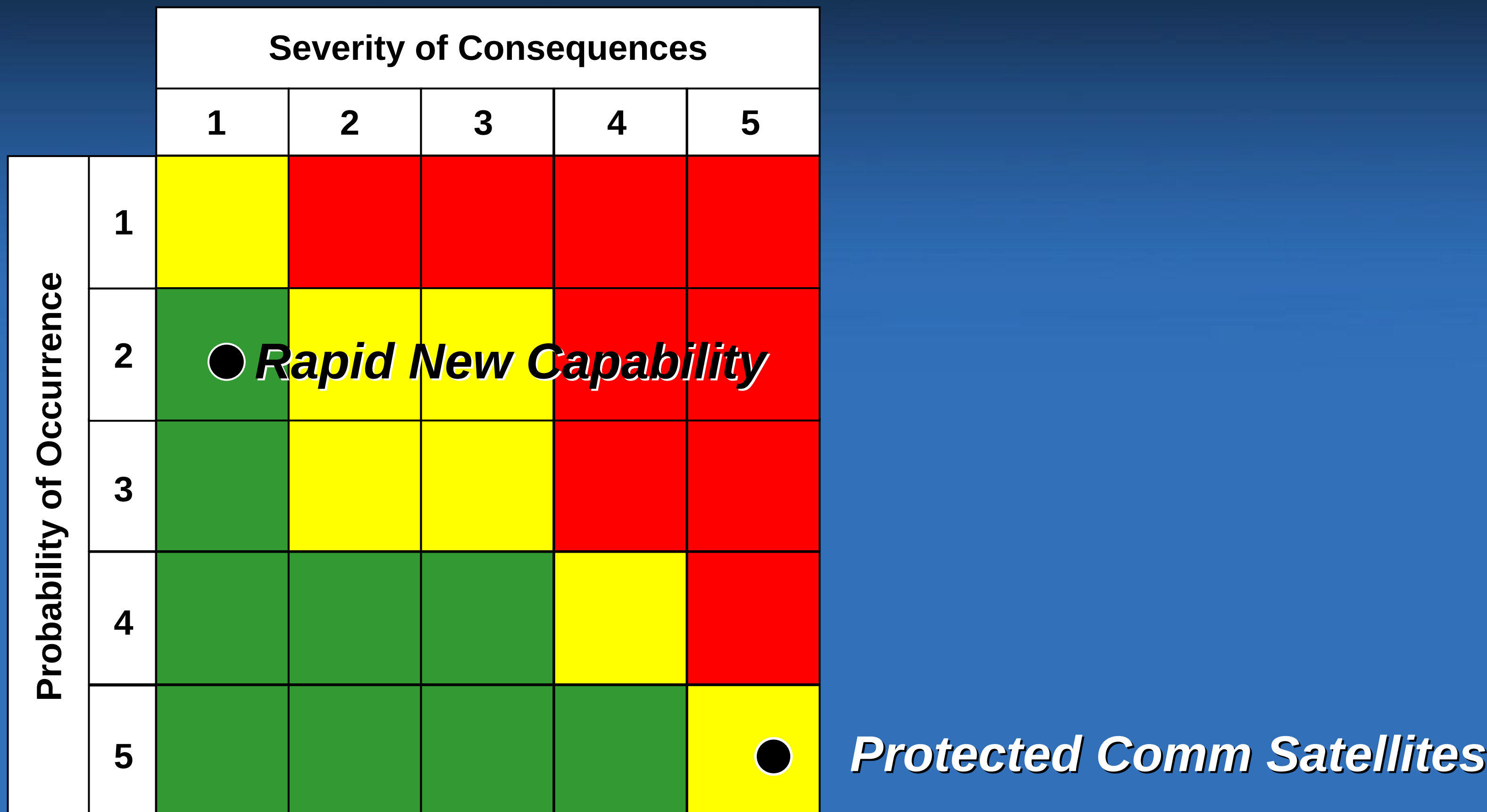
- 60 - "Serious" Fires
- 800 - Elevator rescues
- 80,000 - Calls to 911
- 10,000 - Police on duty

<u>Toronto</u>

- 1,484 - Fire calls
- 110 - Elevator rescues
- 114 - Looting cases
- 38 - Blackout related arrests

Where Can You Not Afford to Fail?

Managing risk in a portfolio of assets



Challenges in balancing performance and risk

Development Risks	Balancing Approach
• **New missions** – No heritage infrastructure – No heritage acquisition community – No heritage domain knowledge	• **Maximum leverage of Government and industry 25 year heritage:** – Experience and domain knowledge – System engineering – Lessons learned and development processes – Requirements and configuration management – Facilities, hardware and software
• **New requirements** – No heritage development – No heritage system engineering – No heritage domain knowledge	
• **Large development steps** – Over long life span – Over significant quantity build	• **Block upgrades** – Technology insertion on-ramps – Milstar / AEHF proven insertion heritage – On-orbit upgrades
• **New technology and integration**	• **RR&SD** – Technology maturity – Integration maturity

25 years of Protected Milsatcom Network Transformation




	x	10x	100x	1000x
Capacity	⇨ ~4 Mbps	⇨ ~40 Mbps	⇨ ~400 Mbps	⇨ ~4 Gbps
Intersat link	⇨ ~10 Mbps	⇨ ~10 Mbps	⇨ ~60 Mbps	⇨ >10 Gbps
Coverage	⇨ 9 beams	⇨ 16 beams	⇨ 37 beams	⇨ 73 beams
	Milstar I ⇨	**Milstar II** ⇨	**AEHF** ⇨	**TSAT**

new start F1 .....

new start F1 F2 F3

spiral F3 F4 F5 F6

new start F1 F2

Gen 1
- LDR Payload
- Space network/on-board routing
- Agile MBA Antennas
- Crosslink Payload

Gen 2
- Milstar Alternative Processor
- MDR Payload
- Nulling Antenna

Gen 3
- Uplink Signal Processor
- Consolidated Agile Beam Antenna

Gen 4
- XDR Payload
- Phased Array Antennas

Gen 5
- XDR+ Payload
- IP Router
- Lasercom

Processing

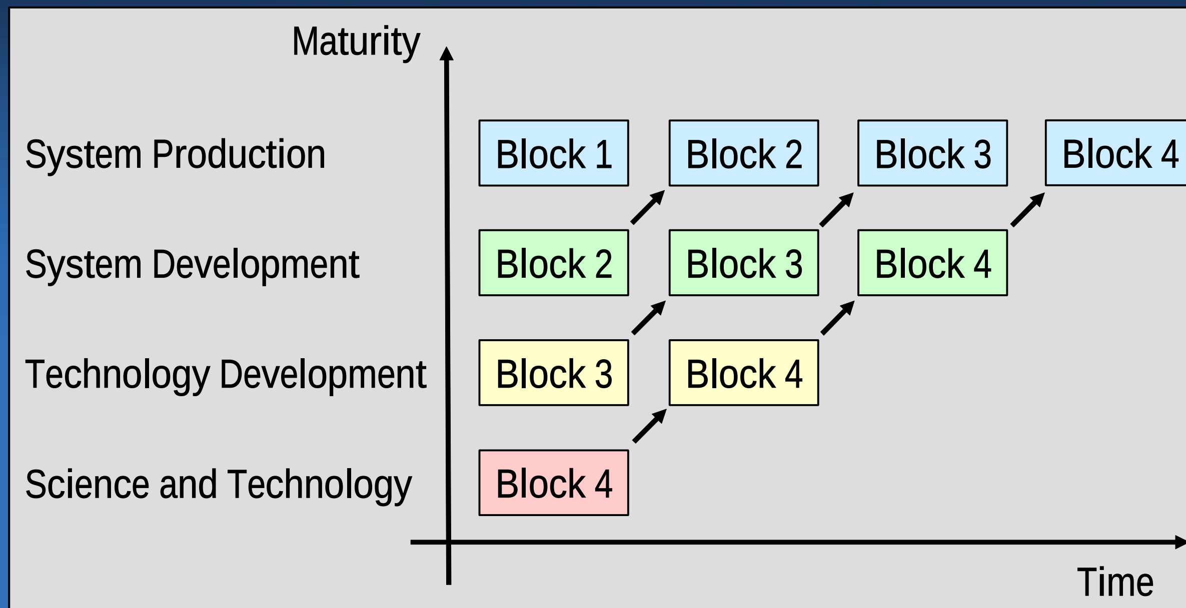
Antennas

83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18

Picking the Right Program

Block Development Enables Low Risk Transformation

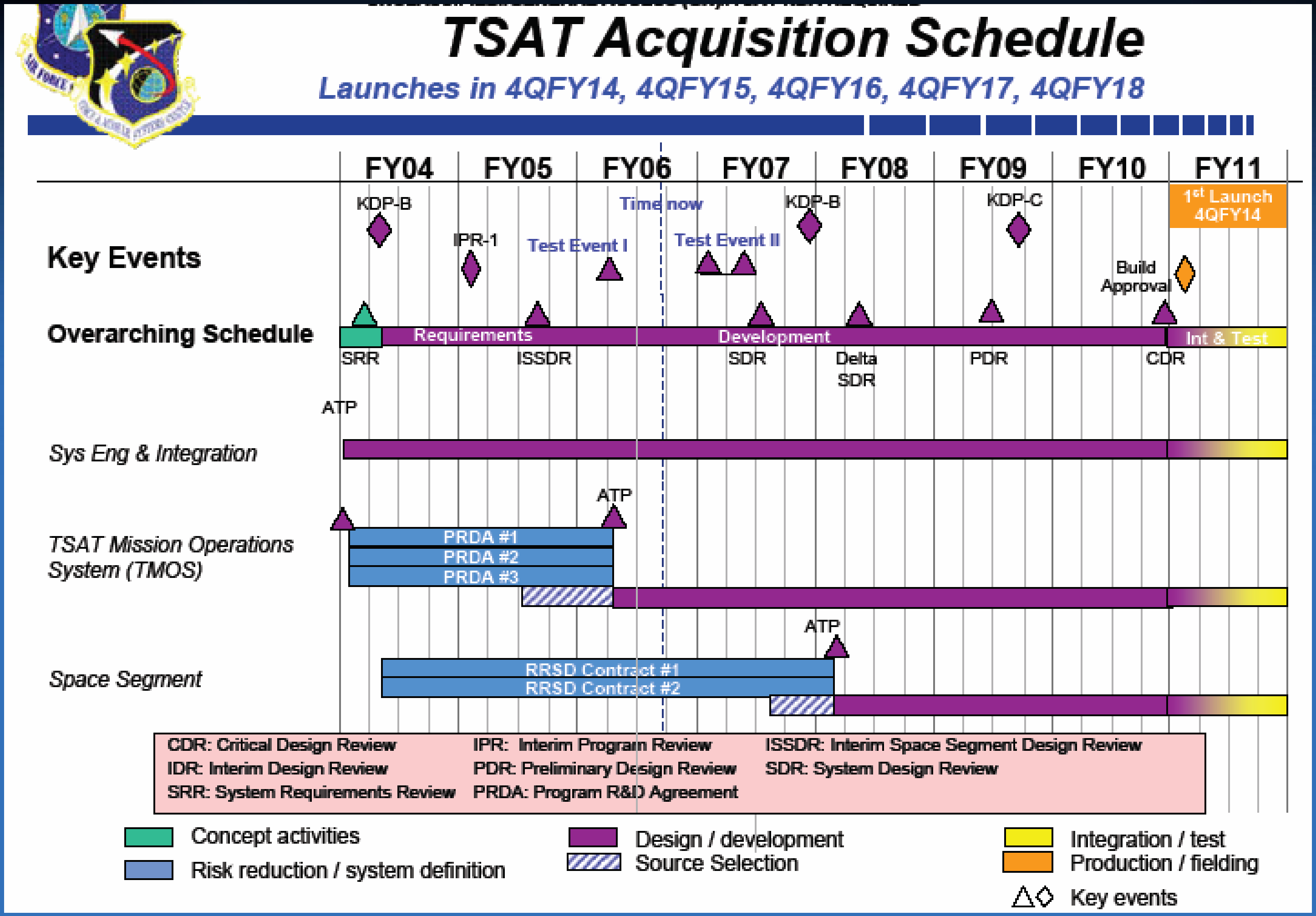
Low Risk System Production,
Take Risk in Technology Development



Block Options with Increasing Capability

Picking the right Acquisition Approach

Risk Reduction & System Definition (RR&SD)



All TSAT technologies achieving TRL-6 or higher

Applying the Lessons Learned and Proven Processes

Requirements Definition

Baseline Conceptual Design

- Subsystem/unit specs
- Hardware/software allocation
- Algorithm definition
- Allocation to units and ASICS

Design and Integration

ASIC & Unit Design

Software Design

- HW/SW co-development
- VHDL Design and Simulation
- Software object model and pseudocode
- Board and interface design

Unit/ASIC HW/SW Integration & Verification

Subsystem HW/SW Integration & Verification

- HW/SW integration
- SW integration
- Performance Verification
- Interoperability testing

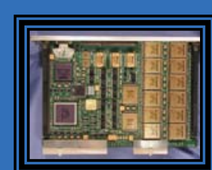
Brassboard Demonstration

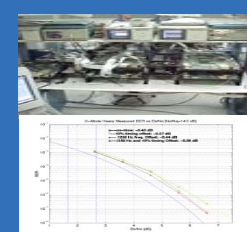
Production

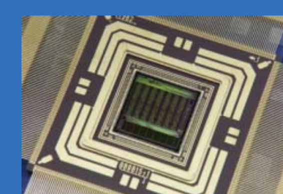
Processor and ASIC Production & Verification

- Manufacture
- Assembly
- Integration
- Test

TRL 3 4 5 6 7 8

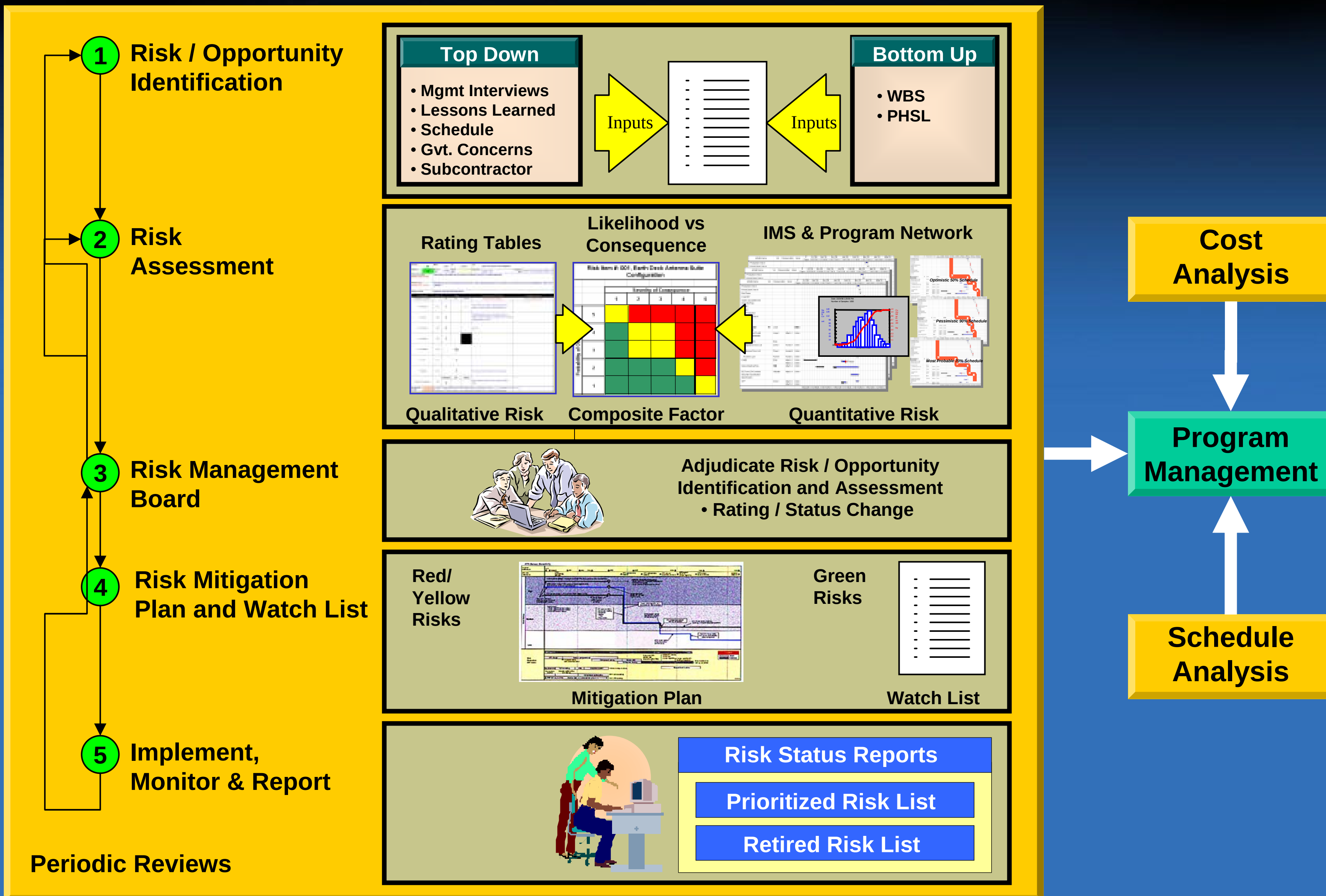






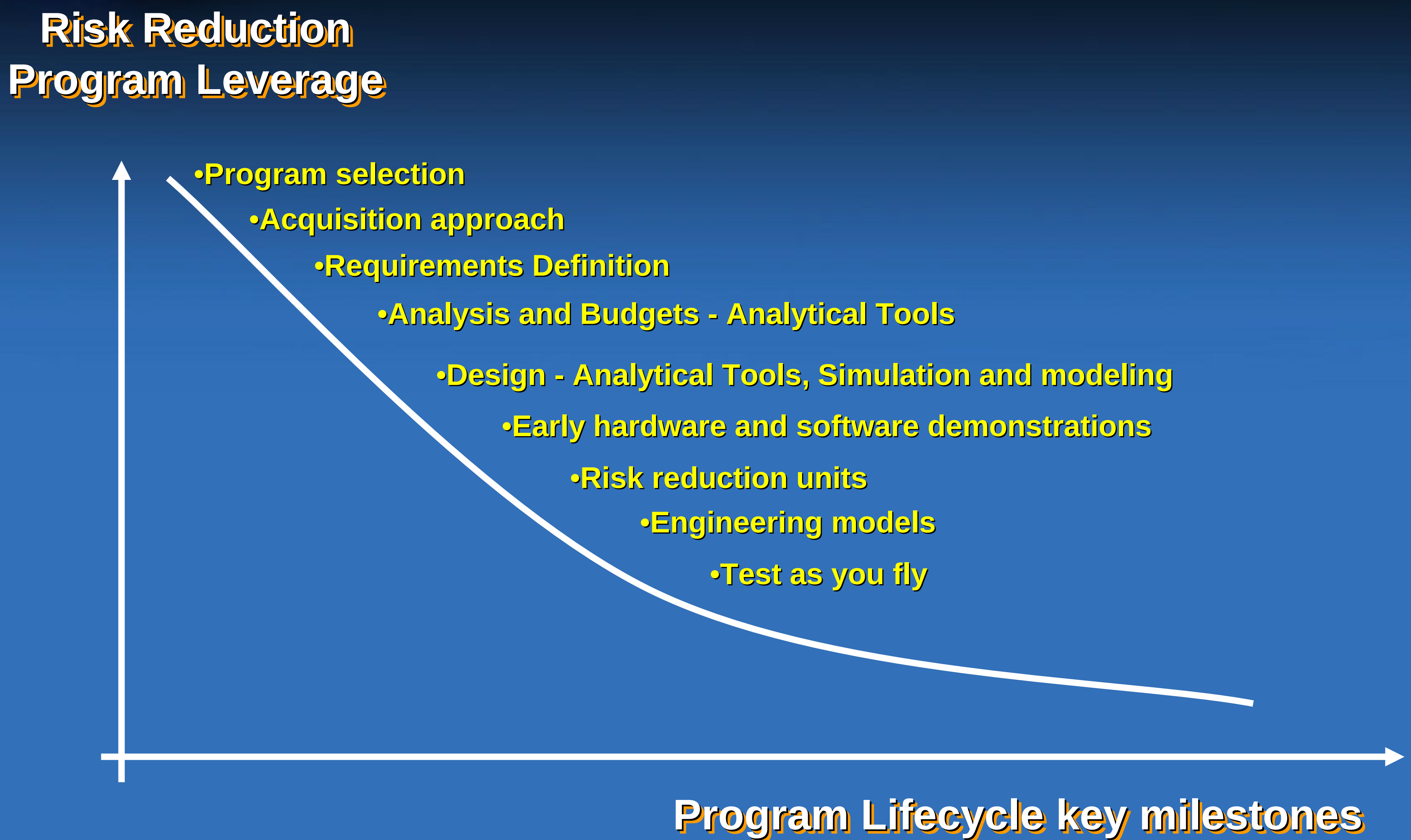
As complexity advances risk management needs to advanced

Applying Proven Risk Management within the Program



Understanding the Risk leverage as a function of time

Risk management through the life cycle



FUTURE COMBAT SYSTEMS

FCS

One Team-The Army/Defense/Industry

NDIA Conference
“Reducing Technology Risk in Acquisition Programs”

BG Thomas Cole

Deputy Program Manager for Future Combat Systems
Brigade Combat Team Platform Integration

Dan Zanini

LSI Deputy Program Manager, Future Combat Systems
Senior Vice President, SAIC

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Agenda

- FCS Program Overview
- Technology Development Process
- Current & Future FCS Technology Options
- Software Developmental
- Cross Command Collaboration Effort
- FCS Program Accomplishments
- FY07-08 Path Forward

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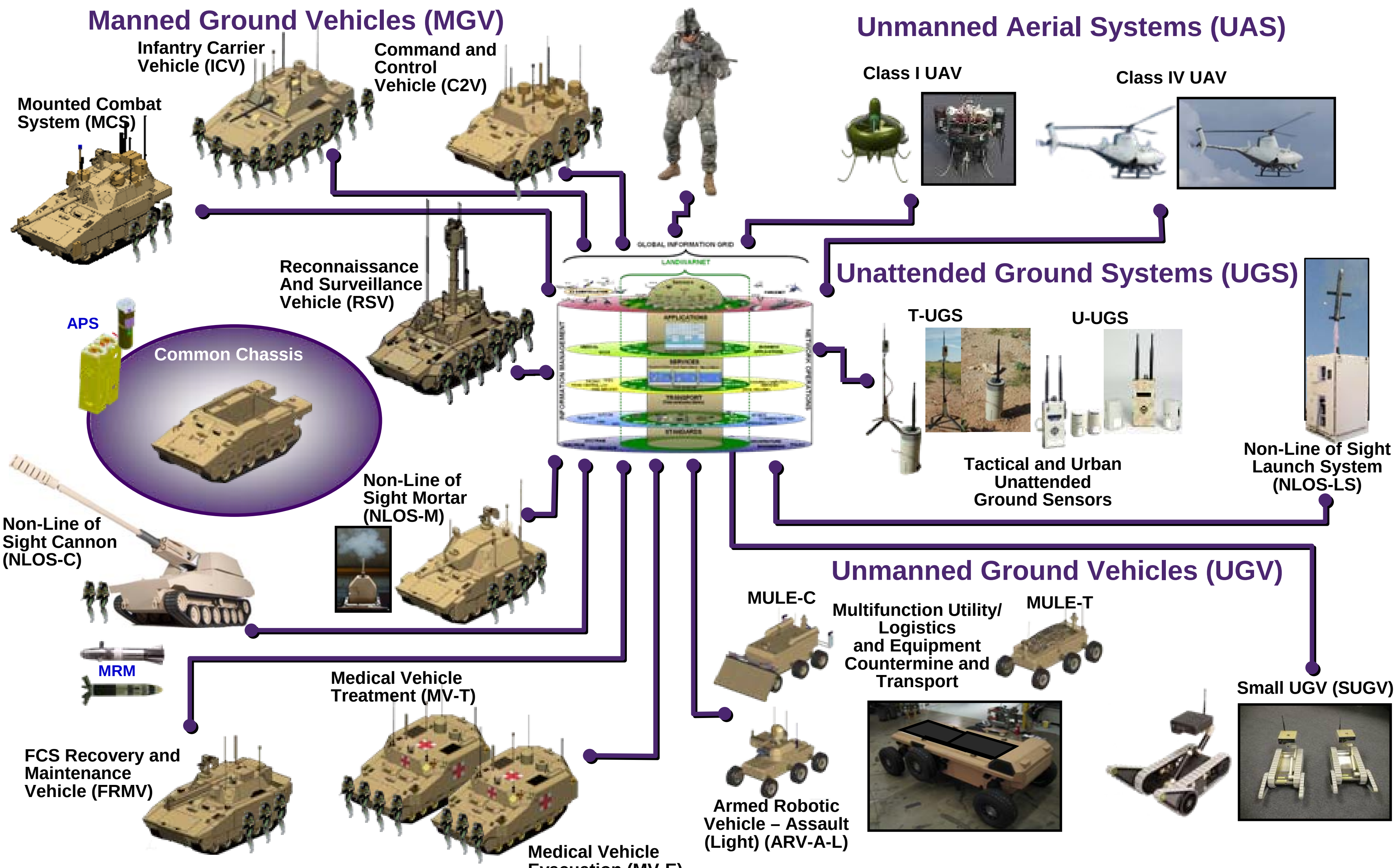
FCS Brigade Combat Team...



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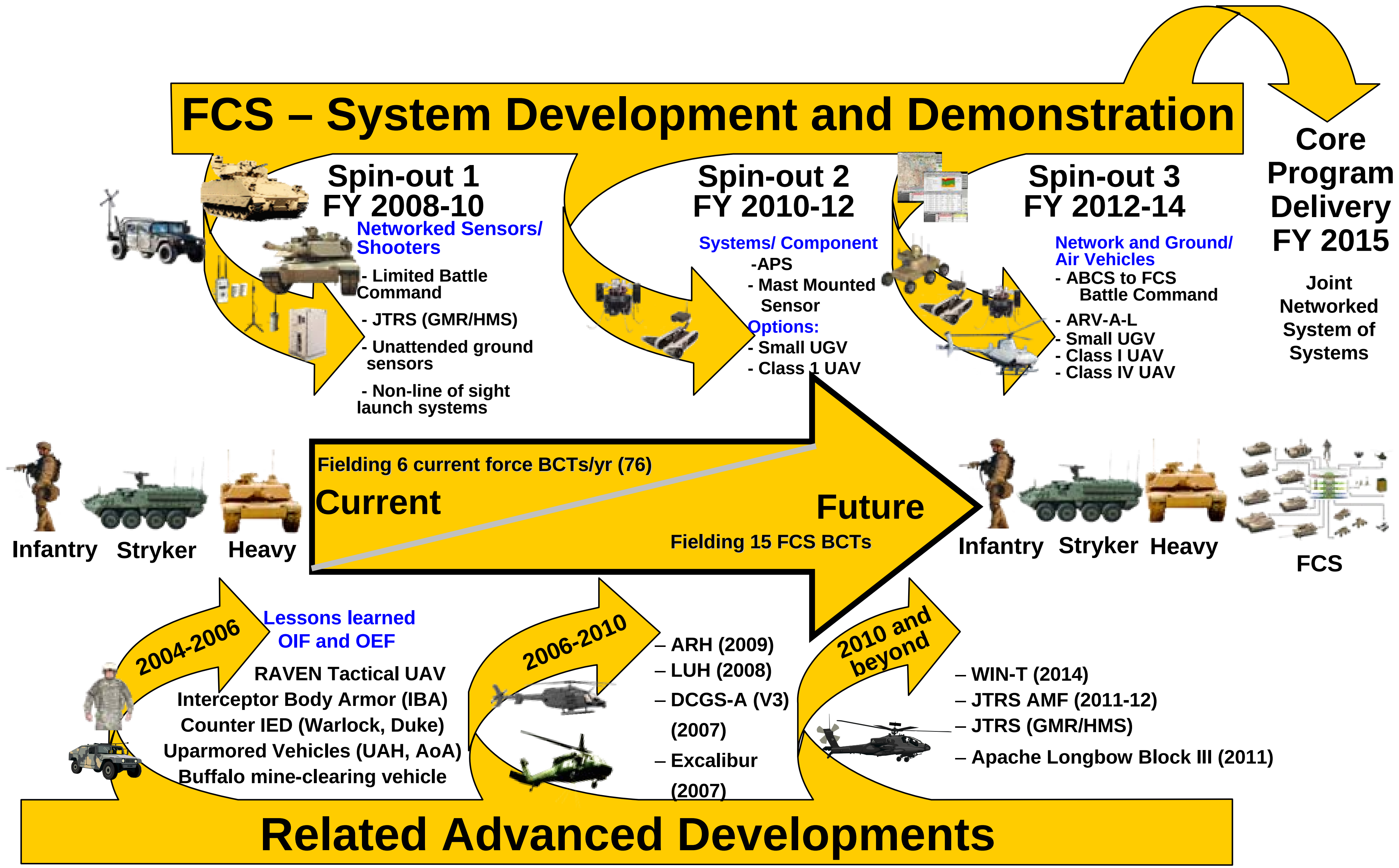
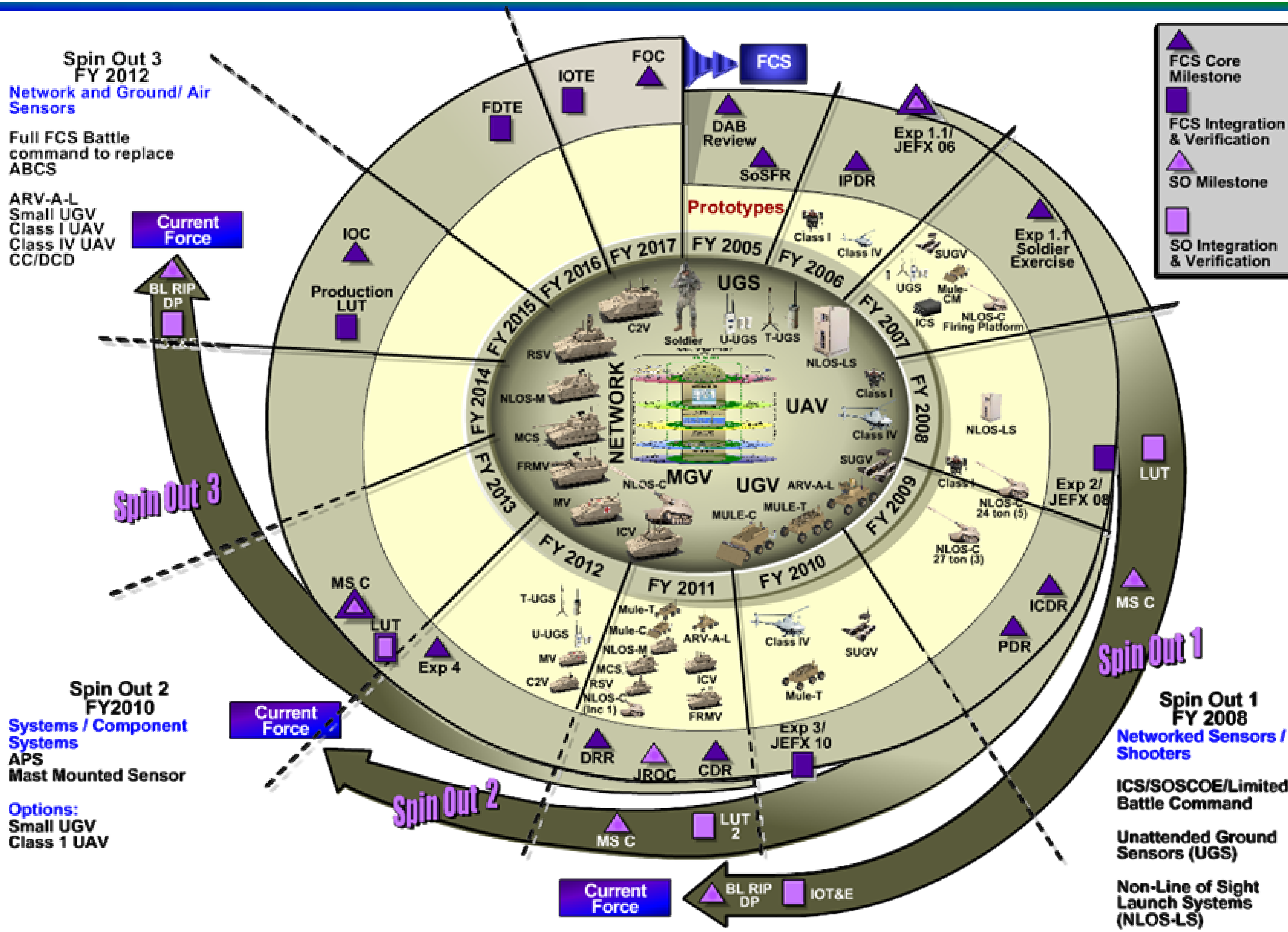
Current to Future Force Through Technology Spin Outs

FUTURE COMBAT SYSTEMS
One Team-The Army/Defense/Industry



FCS (BCT) System-of-Systems Schedule



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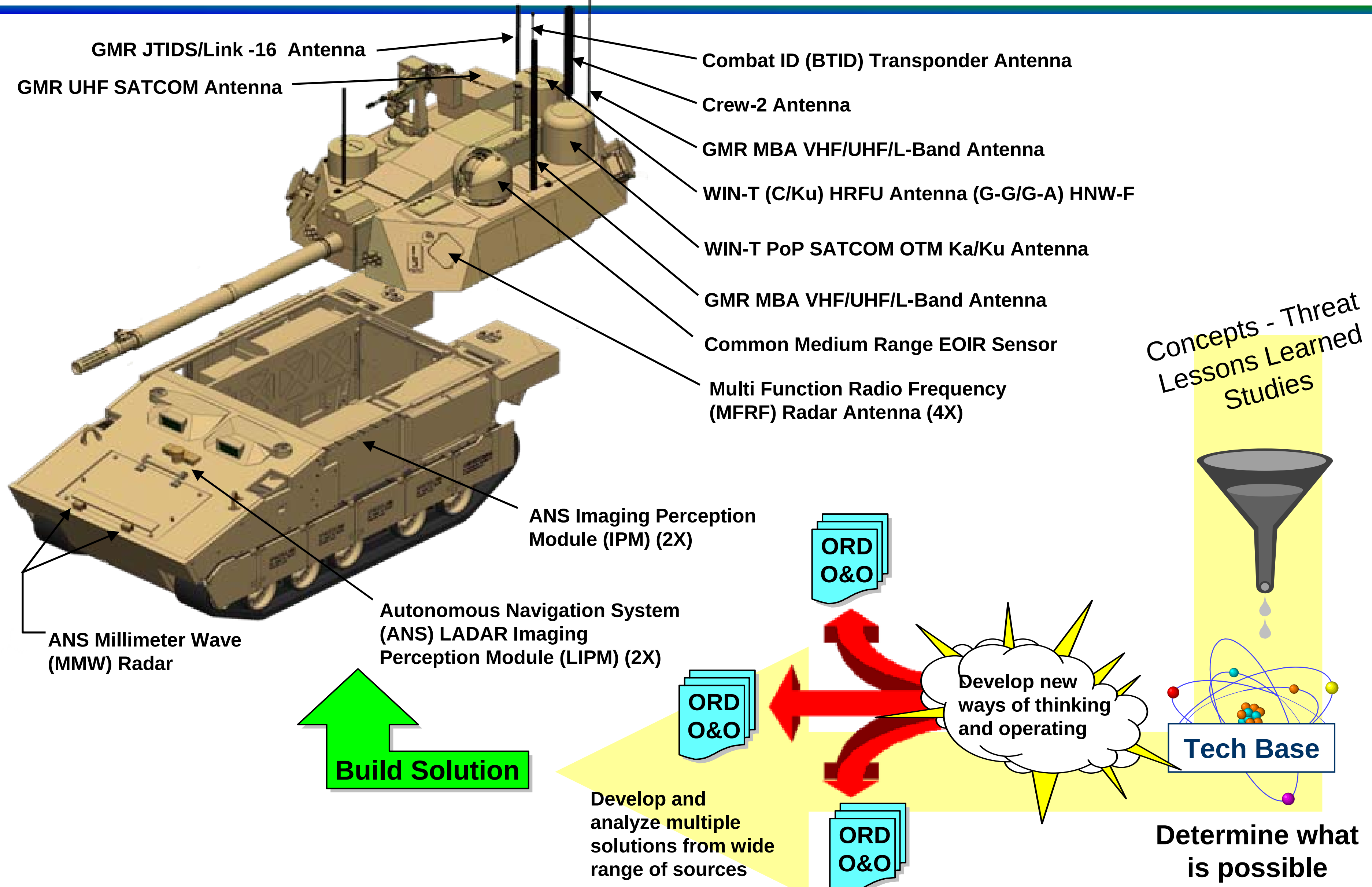
Requirements Determination
A New Paradigm



Concept and Technology Development Phase Modified for FCS SoS

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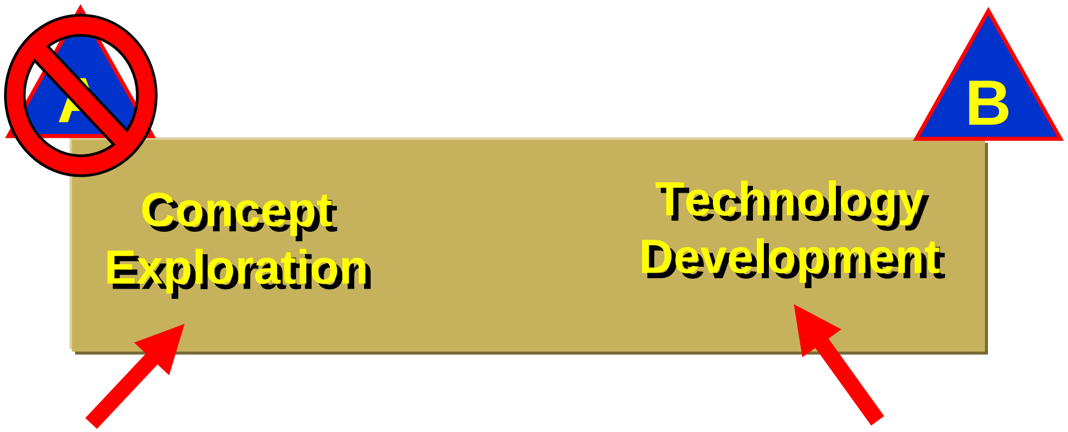
One Team-The Army/Defense/Industry



Concept Exploration

Enter: Validated and approved Initial Capabilities Document.

Activity: Paper studies and Simulations of alternative solutions to the initial concept.

Exit: MDA selects preferred solution to be pursued.

Technology Development

Enter: Project manager understands solution as part of the integrated architecture and its DOTMLPF implications.

Activity: Technology development and critical demonstrations focused on Integrated Concepts tied to Spiral 1.

Exit: Affordable increment of systems as well as FCS SoS Critical Integrated concepts with military-useful capability identified and demonstrated in a virtual and relevant environment – normally can be developed for production within 5 years.

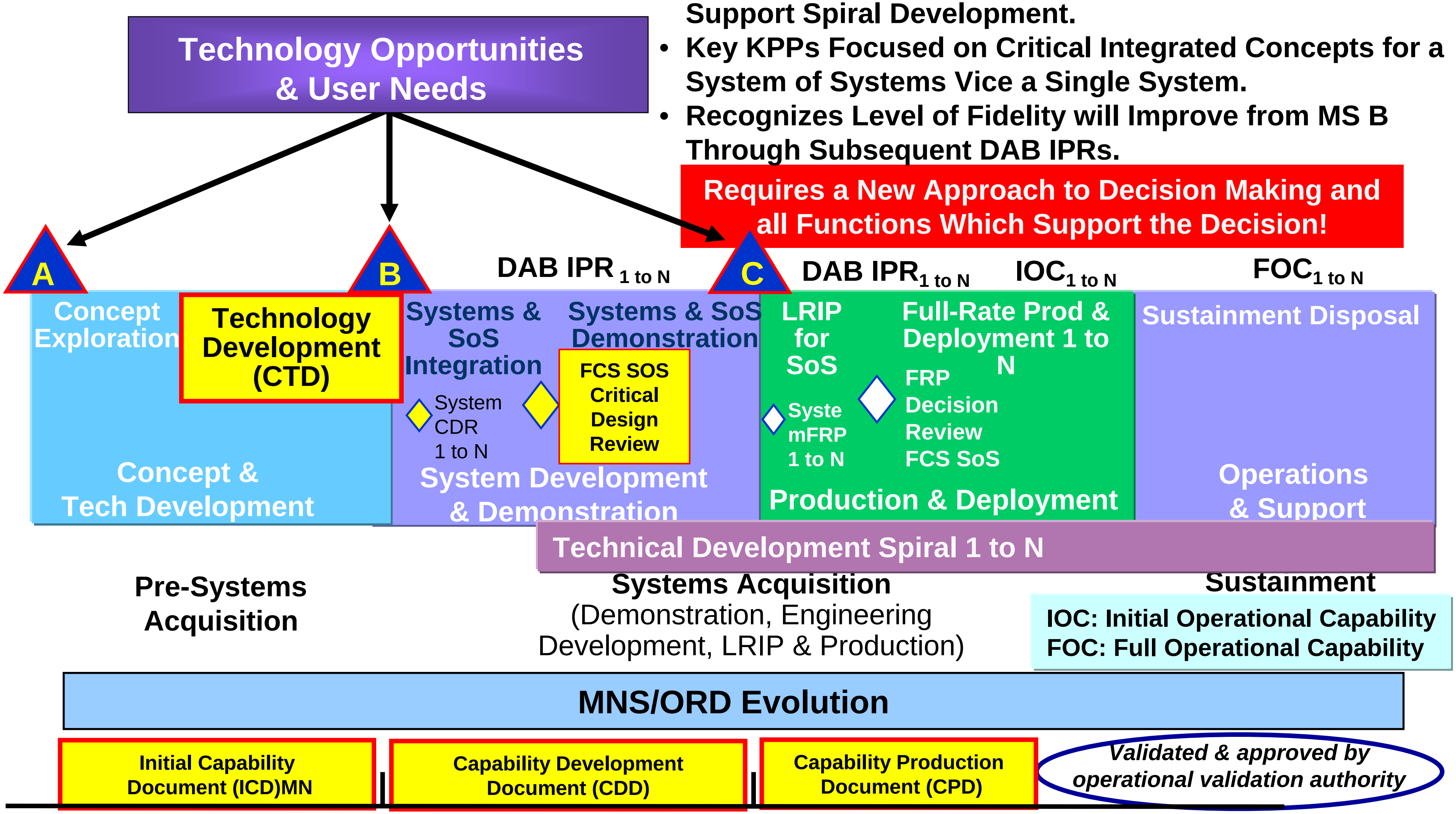
Focus on Integrated Schedule, Master Plan and System of Systems Specification Development and Requirements Crosswalk

The 5000 Model (tailored for FCS)

FUTURE COMBAT SYSTEMS FCS One Team-The Army/Defense/Industry

(30 October 2002)

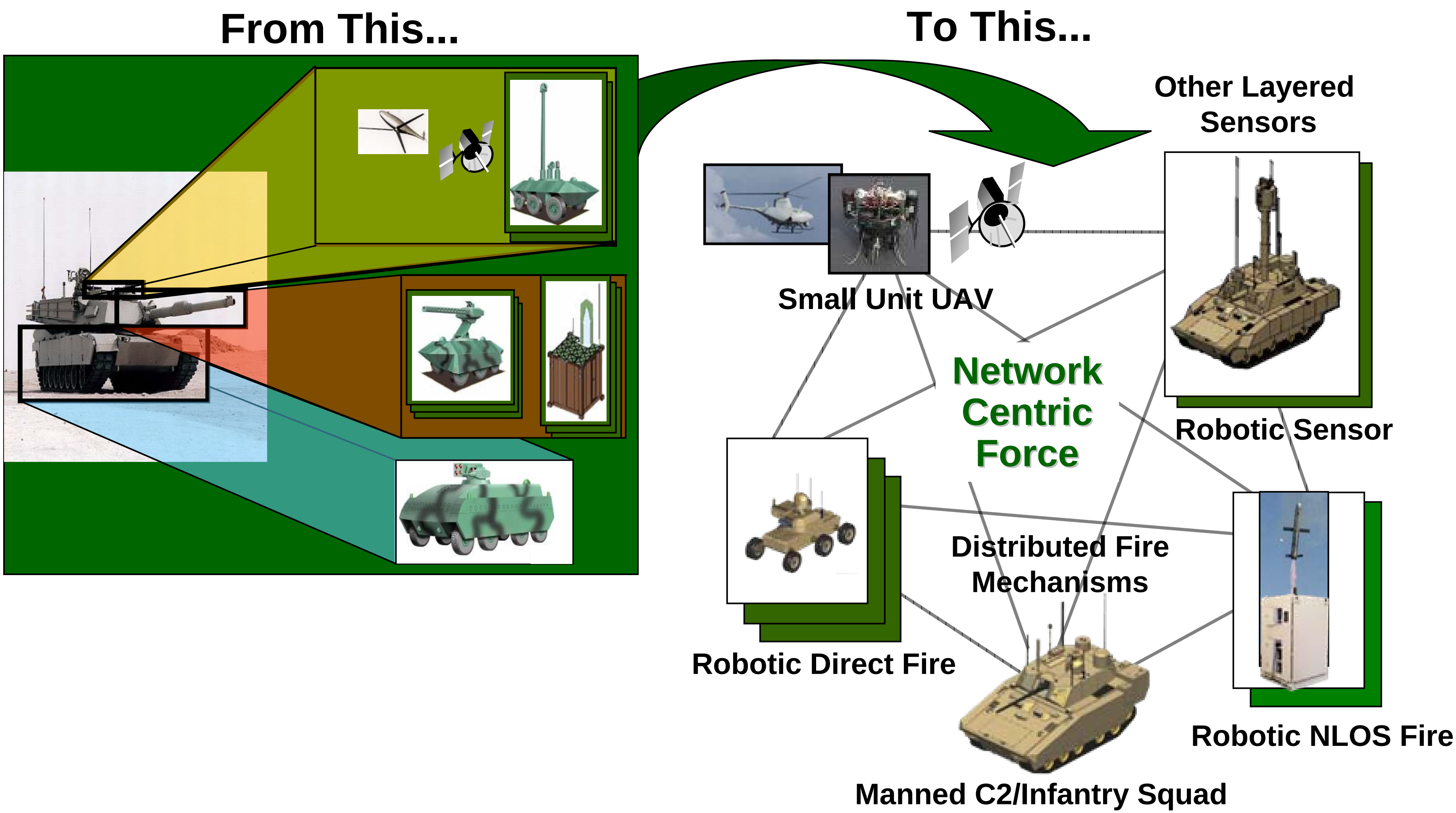
- **Recognizes a Spiral Decision Process is Required to Support Spiral Development.**
- **Key KPPs Focused on Critical Integrated Concepts for a System of Systems Vice a Single System.**
- **Recognizes Level of Fidelity will Improve from MS B Through Subsequent DAB IPRs.**



Relationship to Requirements Process

Technical Approach
Network Centric Distributed Platforms

FUTURE COMBAT SYSTEMS
One Team-The Army/Defense/Industry



Exploit Battlefield Non-Linearities using Technology to Reduce the Size of Platforms and the Force

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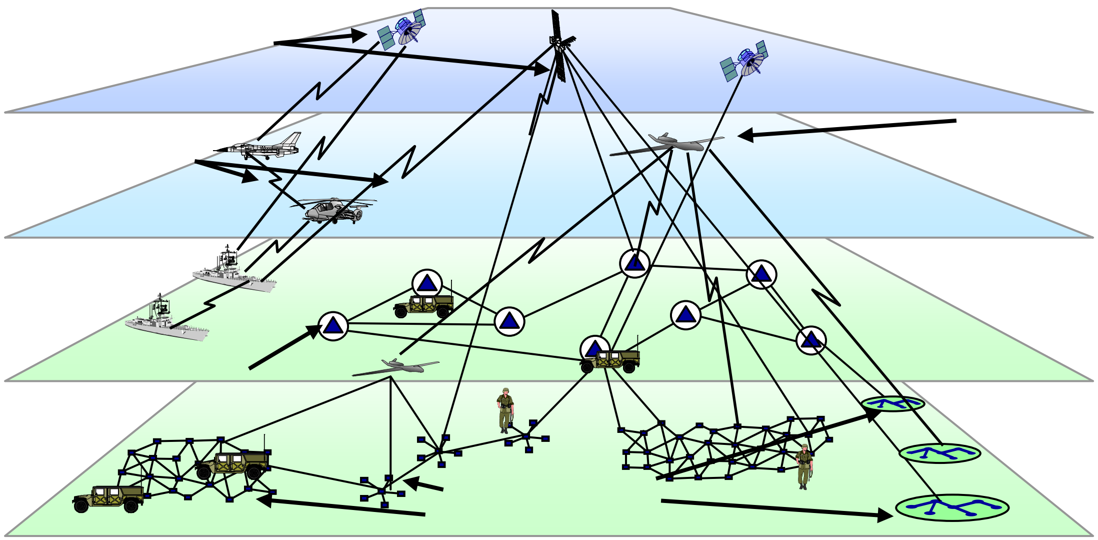
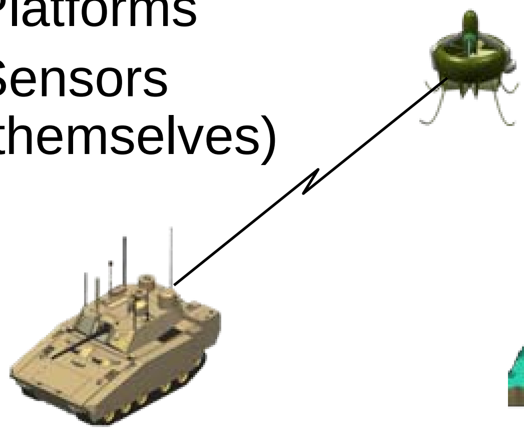
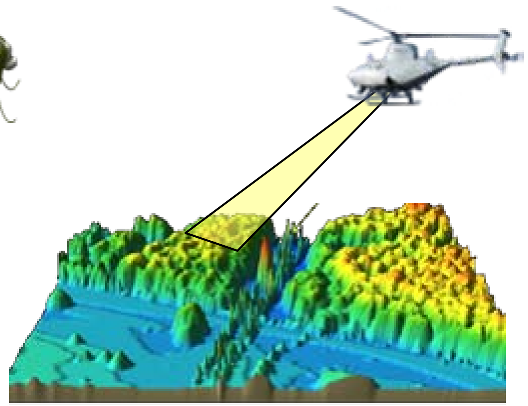
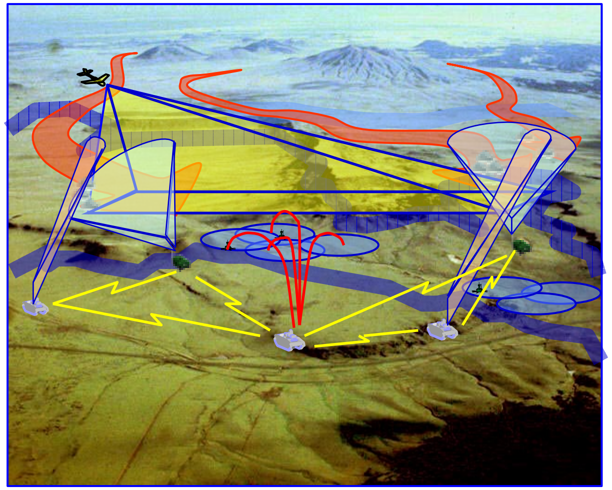
Major Technology Challenges

- **Robotics**
  - Behavior
- **Platforms**
  - Design & Mobility
- **C4ISR/T**
- **Beyond Line of Site Networked Fires**
- **Sensors**
  - Platforms
  - Sensors (themselves)



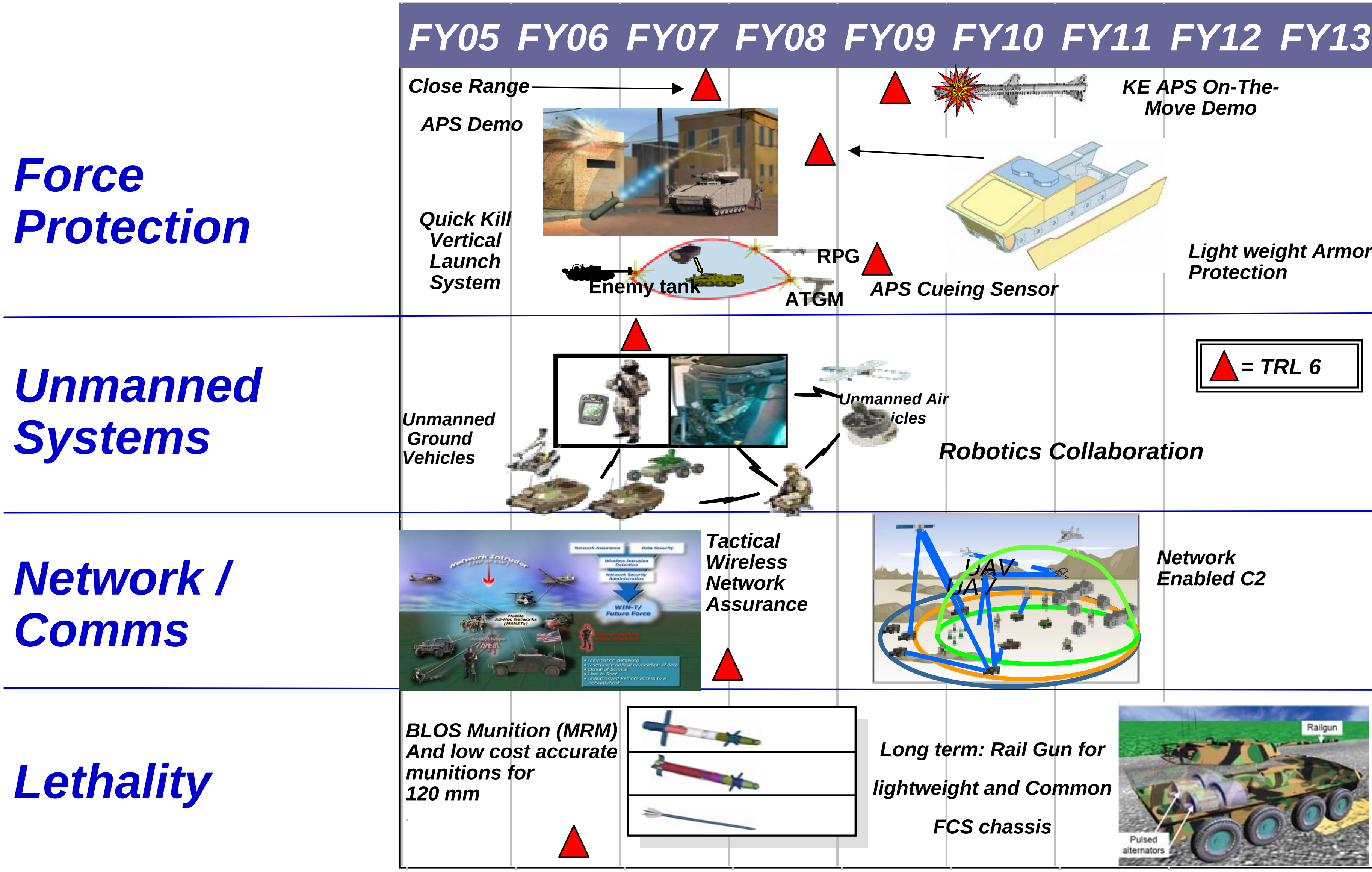






Technologies for the Future Force

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry



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Technologies For the Future Force

FUTURE COMBAT SYSTEMS

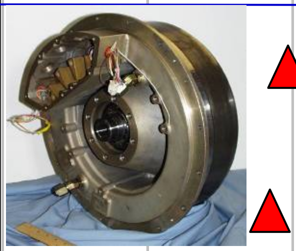
One Team-The Army/Defense/Industry

	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13

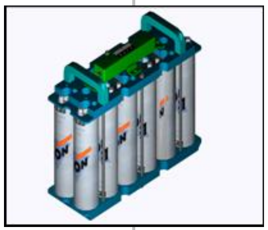
Mounted Soldier Interfaces

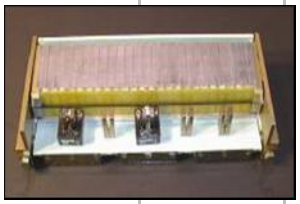
Distribute Aperture Systems Mounted Inside hatch 360 degree view

Propulsion & P&E



Hybrid electric Engine Traction Drive Motor

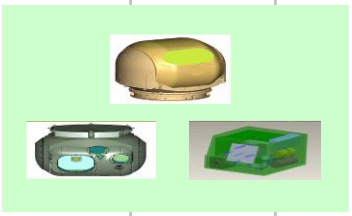




Li-Ion battery module w/ distributed DC/DC power converter

Sensors for Future Force

3rd Generation IR FCS MREO FLIR



ARH *Mini-LRAS3*

ARTEMIS - Foliage penetrating radar for CL IV UAV

Recent Significant Events

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Demonstrations and Technologies On Track

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FUTURE COMBAT SYSTEMS

One Team-The Army/Defense/Industry

Future Combat Systems SOS SW Acquisition Management

Edgar Dalrymple
Associate Director
Software & Distributed Systems

Tim Peters
Senior Program Director
Software & Distributed Systems

Agenda

- Scope of FCS Software
- Program Management Complexity
- System and Software Description
- Software Developmental Phasing
- Architectural Concepts
- Integration Flow
- Risk
- Program Performance to Date
- Lessons Learned

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FCS SDD Contract Scope

FUTURE COMBAT SYSTEMS
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- **Developmental Engineering for a new fleet of Manned Ground Combat Vehicle (HW & SW)**
- **Developmental Engineering for a new fleet of Unmanned Ground and Aerial Vehicles (HW & SW)**
- **Developmental Engineering for Distributed System (HW and SW)**
  - Networked integration of FCS systems
    - Sensors
    - Effectors
    - Maneuver Elements
  - Networked integration of existing and future Army/Joint Systems
  - Networked/Embedded training
  - Networked/Embedded prognostics/sustainment
- **Development and Integration of Tactical and Strategic Networks**
- **Development of new Army Organizational Structures (Brigade Combat Team) and Tactics, Techniques and Procedures**
- **Development of Modeling and Simulation Environment to support Simulation Based Acquisition (including Operational Test)**
- **Incremental fielding of products to current forces (Spin Outs)**

Fixed Cost and Schedule

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Concurrent Engineering Complexity

FUTURE COMBAT SYSTEMS
One Team-The Army/Defense/Industry

- Operational Concept Development
- Force Effectiveness Modeling
- Tactics, Techniques and Procedures Development
- Operational Architecture Development
- Technology Maturation
- Engineering Process Coordination and Alignment
- SoS Requirements Development
- Platform Requirements Development
- Distributed Systems Requirements Development
- Operational Software Development
- Platform Simulation Development
- Other Models and Simulations (terrain, Red Forces) Acquisition and Integration
- Technical and Operational Test Planning and Execution
- Production planning
- Simultaneous Contract Modification and Execution

All Activities are Currently Ongoing

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All Systems Include Software & Radios

FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Manned Systems


C2V
- ***Common - MGV***
- C2V Mission
- C2V Trainer


MCS
- ***Common - MGV***
- MCS Mission
- MCS Trainer


RSV
- ***Common - MGV***
- RSV Mission
- RSV Trainer


ICV
- ***Common - MGV***
- ICV Mission
- ICV Trainer


MV
- ***Common - MGV***
- MV Mission
- MV Trainer


NLOS-C
- ***Common - MGV***
- NLOS-C Mission
- NLOS-C Trainer


NLOS-M
- ***Common - MGV***
- NLOS-M Mission
- NLOS-M Trainer


FRMV
- ***Common - MGV***
- FRMV Mission
- FRMV Trainer

Unmanned Ground Vehicles


MULE-CM
- ***Common - UGV***
- SU, PPS, L1F, SDM
- PS-MRS
- Embedded Training
- ANS, VMS
- UGV Countermine
- MULE-CM Mission


SUGV
- ***Common - UGV***
- SUGV Mission


MULE-T
- ***Common - UGV***
- SU, PPS, L1F, SDM
- PS-MRS
- Embedded Training
- ANS, VMS
- MULE-T Mission


ARV-AL
- ***Common - UGV***
- SU, PPS, L1F, SDM
- PS-MRS
- Embedded Training
- ANS, VMS
- ARV-AL Mission

Unmanned Air Vehicles


Class IV
- SOSCOE
- NMS
- Air Sensors
- BCME, SDM
- PS-MRS
- Class IV Mission
- JTRS
- HNW


Class I
- SOSCOE
- NMS
- Air Sensors
- Class I Mission
- JTRS

Unattended Sensors


UGS
- SOSCOE
- UGS Mission
- JTRS

War Fighter Systems


CC
- SOSCOE
- SU, PPS, BCME, WMIS, L1F, SDM
- NMS
- PS-MRS, LDSS
- Embedded Training
- JTRS

Unattended Munitions


NLOS-LS
- SOSCOE
- NMS
- CLU Mission
- JTRS

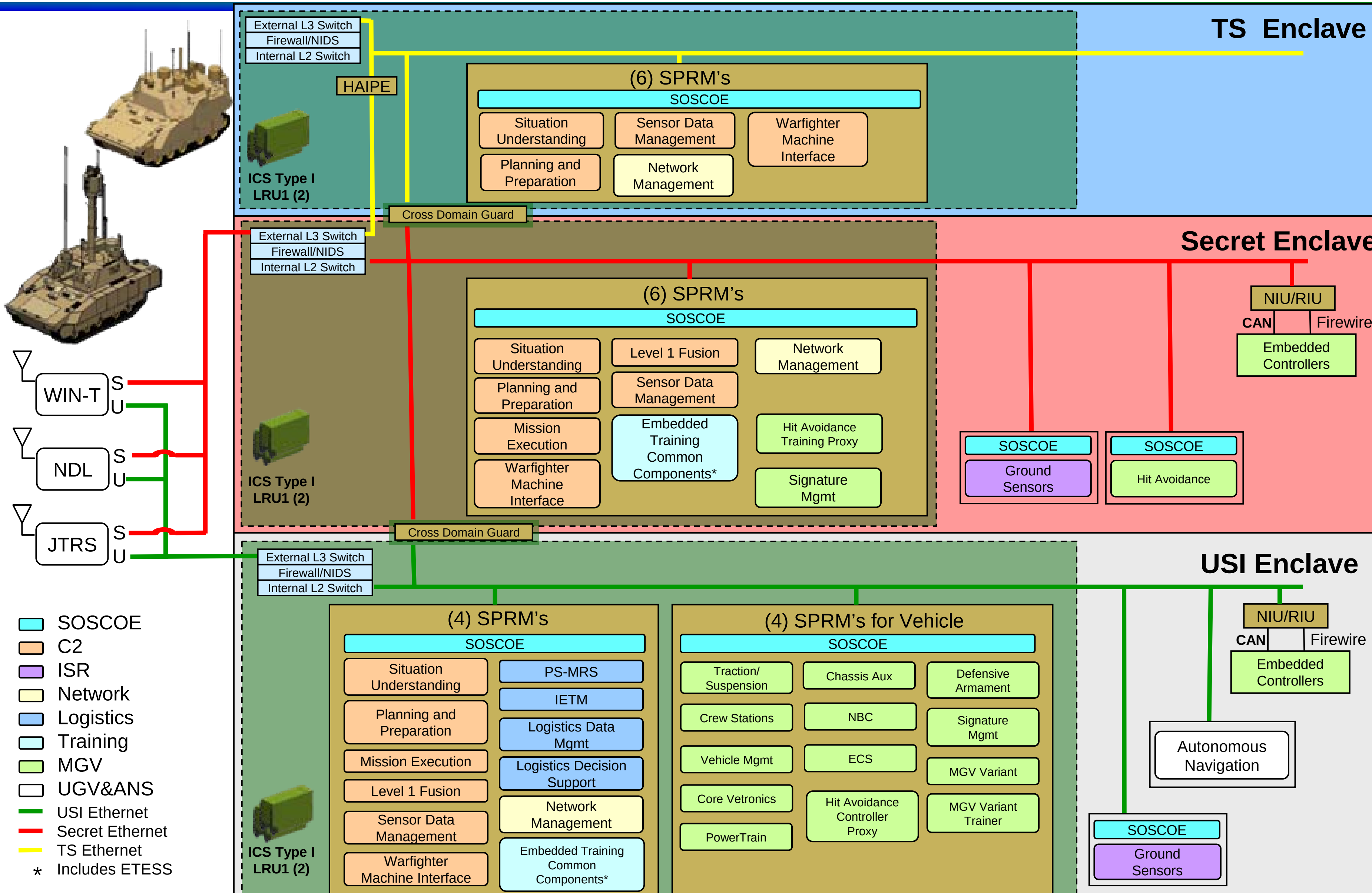
Common – MGV includes:
- SOSCOE
- SU, PPS, BCME, WMIS, L1F, SDM
- Ground Sensors
- NMS
- PS-MRS, LDSS, IETM
- Embedded Training
- MGV Common: Crew Stations, VMS, Core
- Vetronics, Powertrain, Traction/Suspension, Chassis Aux System, NBC, ECS, Active Protection, Countermeasures, Defensive Armament, Signature Management, MGV
- Embedded Training
- ANS, JTRS, MC4

Common - UGV includes:
- SOSCOE
- BCME
- Ground Sensors
- NMS
- JTRS

C2V, MCS, RSV, ICV, MV Only:
- WIN-T PoP (w/HNW) or HNW (only)

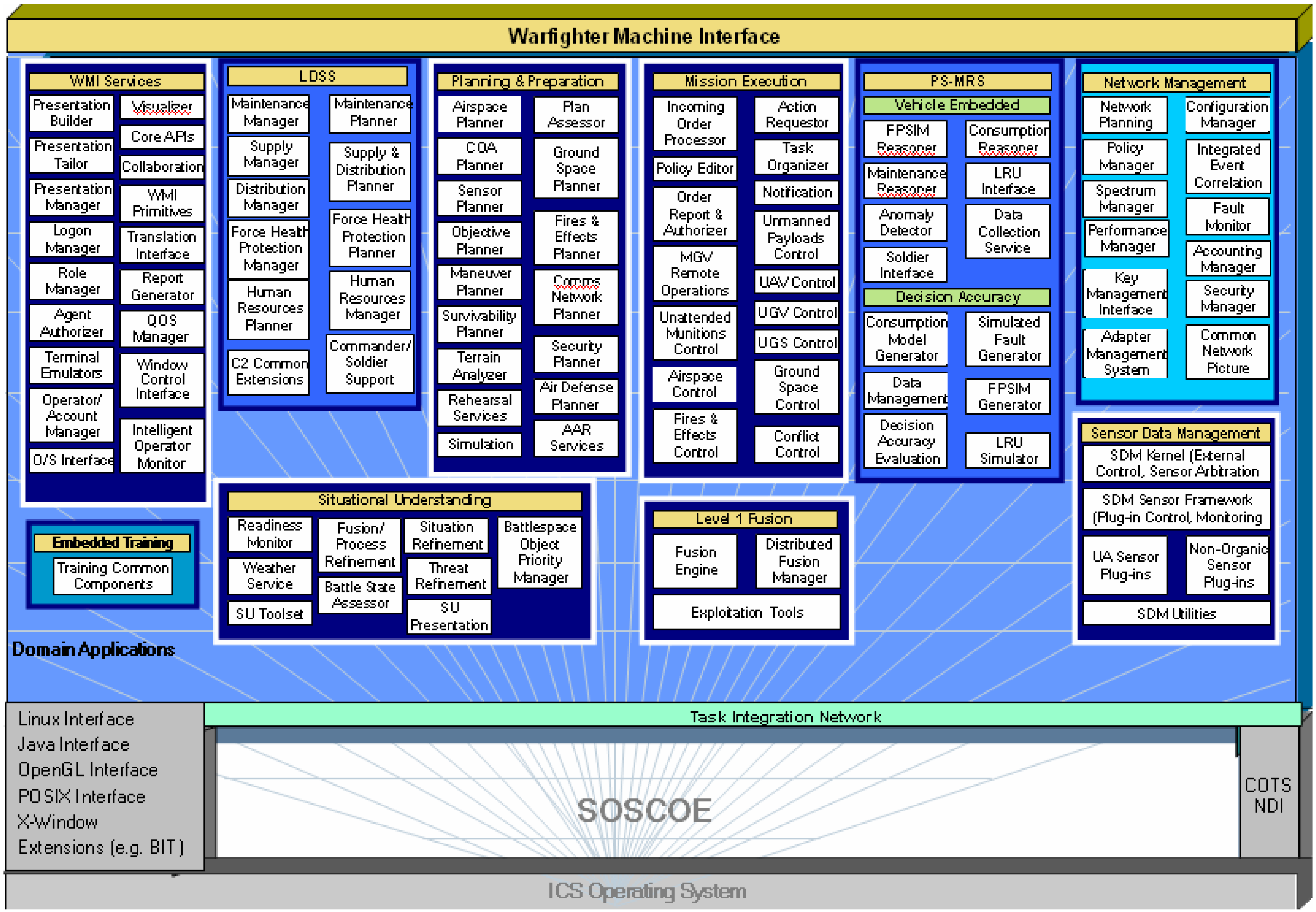
SOSCOE
C2
ISR
Network
Logistics
Training
MGV
UGV&ANS
UAV
Comp Pgm

Preliminary Type I ICS SW Deployment: C2V, RSV



SPRM = Small Processing Resource Module
HAIPE = High Assurance Internet Protocol Encryptor

Common Infrastructure and Application Services



Battle Command Software is Deployed to all FCS Platforms

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100 Software Subsystems in FCS

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SOSCOE	ICS	Air Sensor Integrator		Mule (3)	ICV variant	Crew stations (WMI)	Active Protection
DCD Controller	Network Management Services	Logistics Data Mgmt Svcs	SoS Simulation	SUGV (2)	MEV variant	Vehicle Mgmt System	Counter Measures
Situation understanding	Comm Emulators / Simulators	Logistics Decision Support	UAV Class I	ARV (5)	NLOS-C variant	Core Vetronics	Defensive Armament
Planning and Preparation Services	Air Sensors (7)	PDAVS	UAV Class II	Autonomous navigation (2)	NLOS-M variant	Powertrain	Signature Mgmt
Mission Execution	U-UGS	PS – MRS	UAV Class III	UGV Countermine	MCS variant	Traction/ Suspension	MGV Variant Trainers (9)
Warfighter Machine Interface	T-UGS	Integrated elect tech manual	UAV Class IV	Embedded Training Enablers	C2V variant	Chassis Aux System	MGV Embedded Training
Level 1 Fusion	Ground Sensor Integrator	Network SIL	UAV AiTR	UGV Trainers (4)	RSV variant	NBC	
Sensor Data Mgmt.	Ground Sensors (12)	ISN Integration Software		UAV Trainers (5)	FMRV variant	ECS	

Battle Command SW
- SOSCOE
- Command & Control
- ISR
- Network
- Logistics
- Training

Simulation, Infrastructure & SIL SW

Platform SW
- MGV
- UGV & ANS
- UAV

Best of Industry Teams Develop 80% of FCS Software

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FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

FCS Software Overview

FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017

PDR
CDR
MS C
IOC
IOTE
SO 1 LUT
IV2 LUT
IV 3 LUT
IV 4 LUT
PD LUT
SO1 MS C

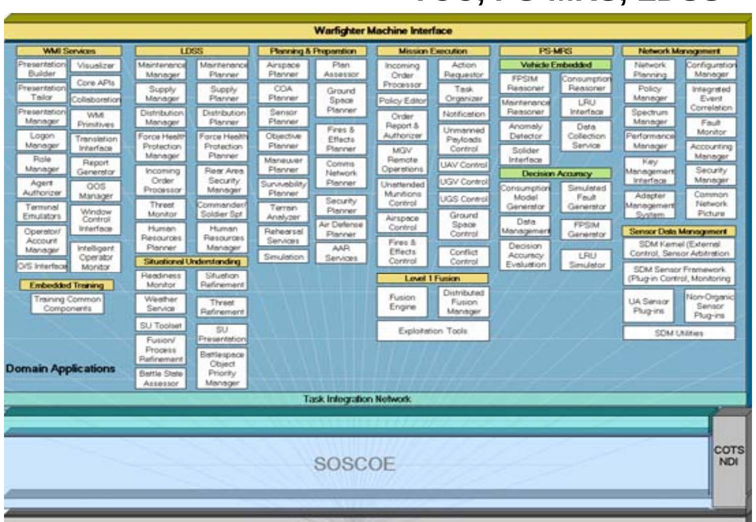
Build 0 – Complete
Build 1
Build 2
Build 3
Build 4

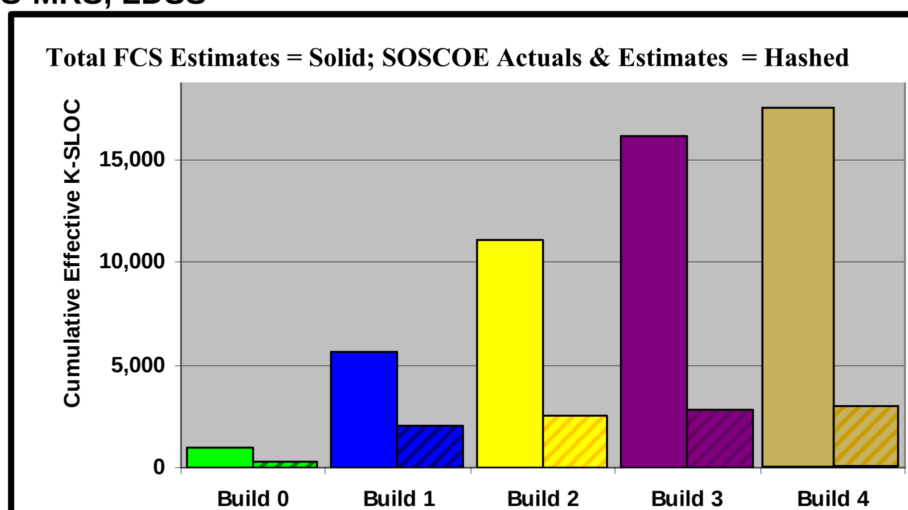
- **Build 1**
- SOSCOE
- Initial Battle Command Systems
- Platform Simulations
- NLOS-C Firing Platform
- UGS-T/U, IMS, NLOS-LS Prototypes
- Vehicle VMS SW
- FSE
- TCC, PS-MRS, LDSS

- **Build 2**
- SOSCOE
- Battle Command System
- UAV/UGV Simulations
- UGS Full Functionality
- SUGV, UAV Class I and IV Prototypes
- Vehicle VMS SW
- FSE
- TCC, PS-MRS, LDSS

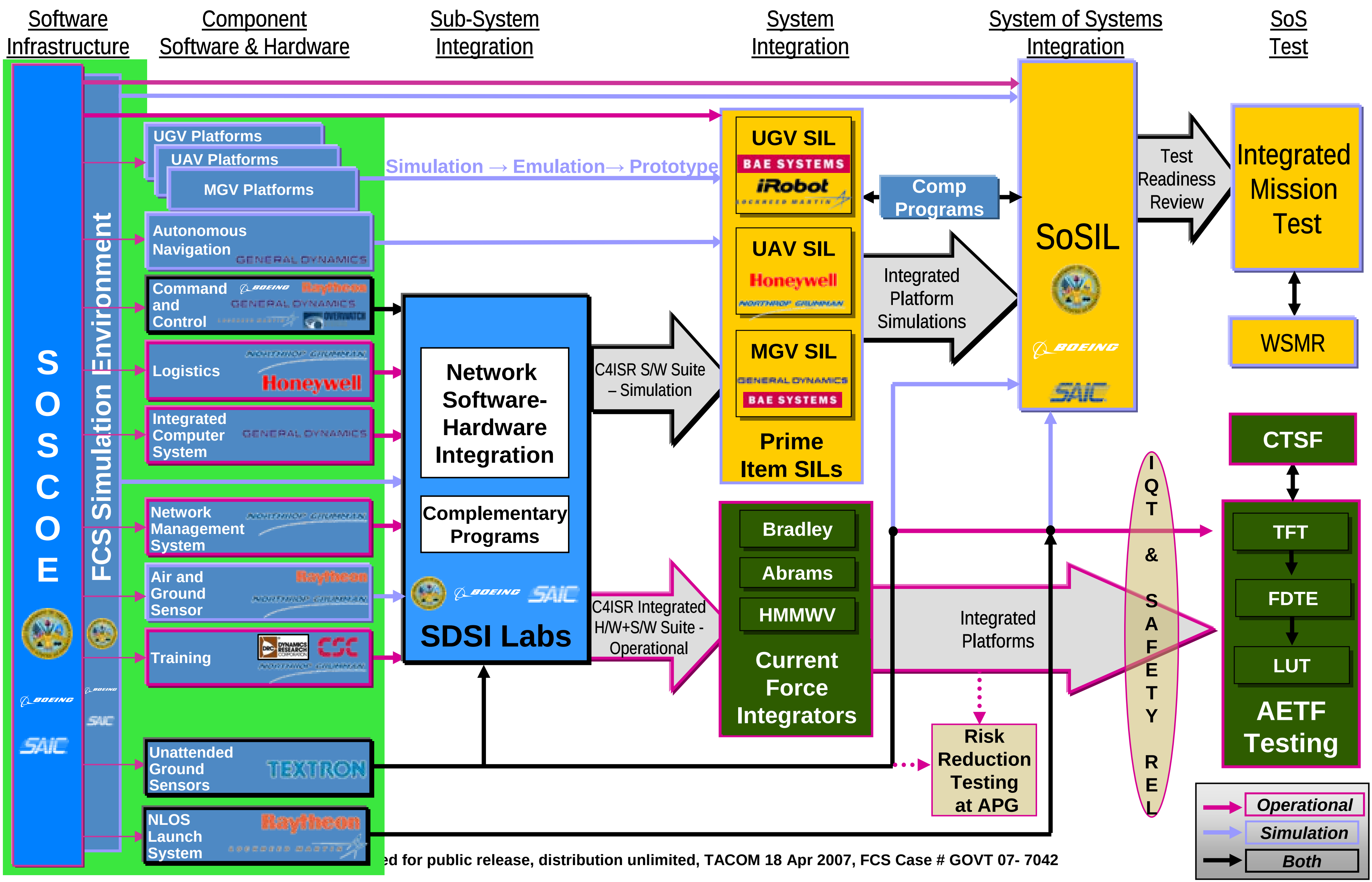
- **Build 3**
- SOSCOE
- Battle Command Maturation
- Autonomous Navigation
- All MGV/UGV/UGS Prototypes
- Embedded Training
- PS-MRS, LDSS

- **Build 4**
- FBCT Full Functionality





Software and Hardware Integration Flow



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Performance to Date

- **Two Major SOSCOE builds (1.0.5.0 and 1.0.8.0) developed and delivered on time**
- **OTPs delivered 5M SLOC to LSI on 1 March 2007**
  - B1F to Spin Out Limited User Test
- **Conducted Experiment 1.1**
  - Live soldiers
  - UGS and SUGV prototype HW and SW
  - Distributed COP
- **Conducted Integrated Mission Test 0**
  - Demonstrated initial M&S capabilities
  - Integrated platform simulations, GFX models, and FCS Simulation Environment
- **Fired live rounds with Pre-production prototype Cannon using operational SW**

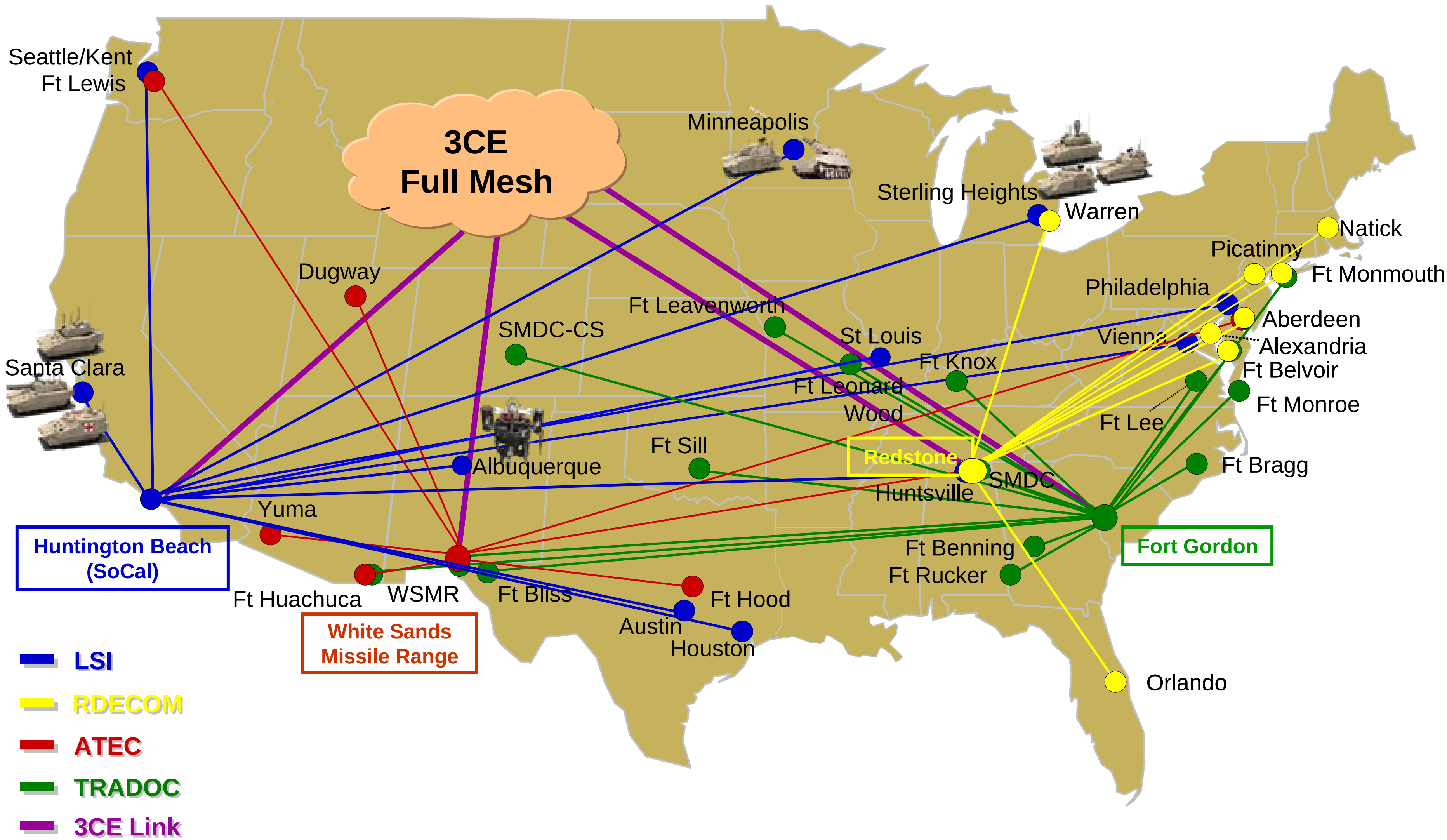
FUTURE COMBAT SYSTEMS

One Team-The Army/Defense/Industry

Cross-Command Collaboration Effort (3CE)

Phil Zimmerman

Distributed SoSIL



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3CE Mission and Intent

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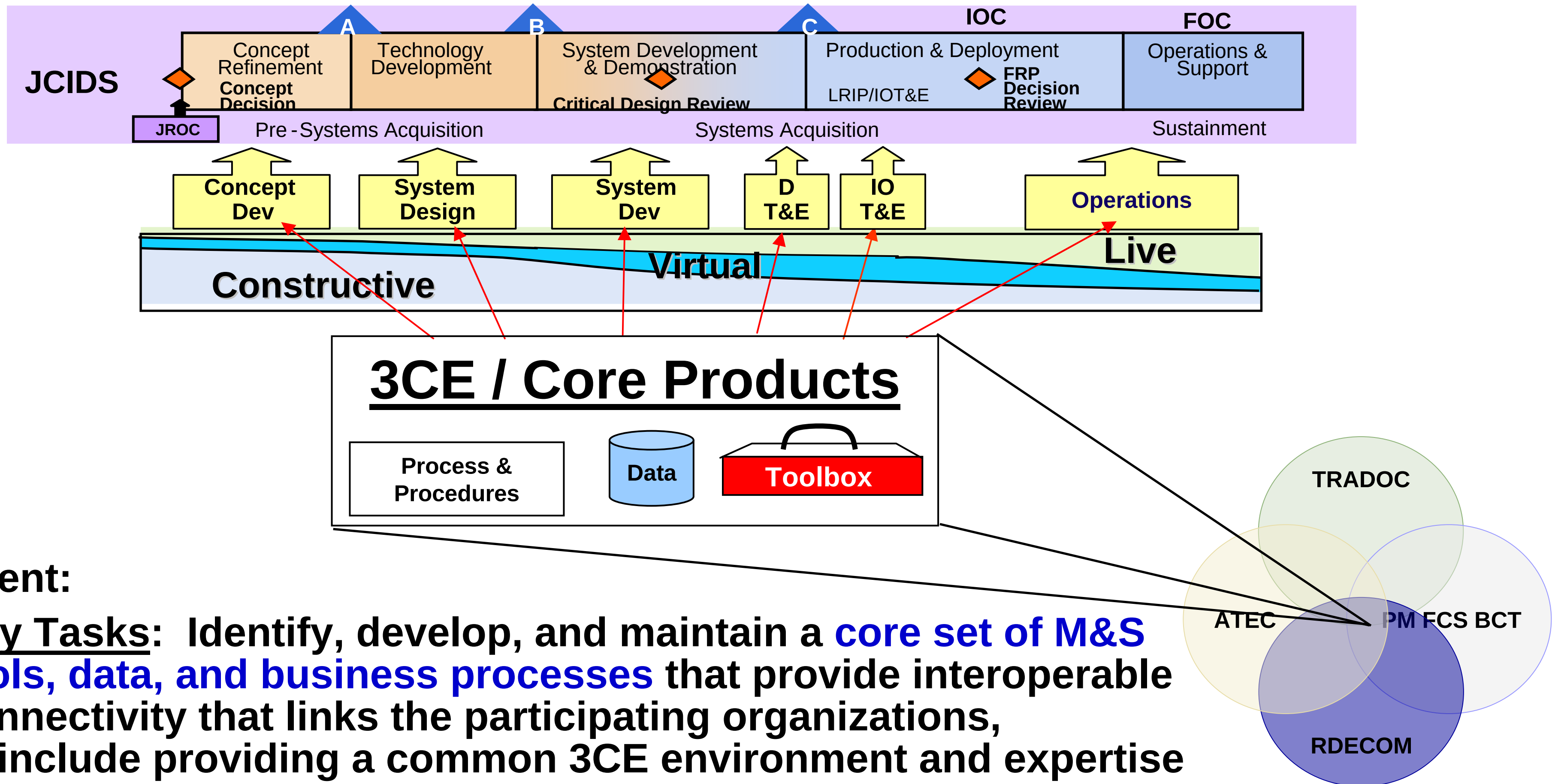
One Team-The Army/Defense/Industry

Mission: Develop a cross command Army M&S and data environment for design, development, integration, and testing of capabilities, systems, and prototypes.



Intent:

Key Tasks: Identify, develop, and maintain a core set of M&S tools, data, and business processes that provide interoperable connectivity that links the participating organizations, to include providing a common 3CE environment and expertise for the Army to leverage.

End State: A 3CE environment that meets the common requirements of all three commands and Program of Record to conduct distributed DOTMLPF development.

Benefits of 3CE to…

The Army

- Provides consistent representation through common tools and data IAW established standards and best practices.
- Provides the capability to leverage a single event for multiple purposes.
- Provides and develops environment capabilities that are traceable to user needs and design requirements.
- Enhances current M&S capabilities and reuse.
- Provides a leave behind capability to support future SoS acquisition programs.

ATEC	RDECOM	TRADOC	Program
▪ Provides a consistent environment for M-T-M ▪ Reduces preparation time for a test ▪ Provides reusable and consistent metrics from development to test ▪ Enhances training proficiency on test equipment	▪ Enables consistent data from field tests ▪ Reduces the number of data requests ▪ Enables leveraging operational capabilities for engineering and performance tests	▪ Enables VV&A to test standards for M-T-M ▪ Reduces time to obtain characteristic data from the program ▪ Leverages multiple events for training ▪ Provides a single environment for analysis, test, and training	▪ Provides a single POC for GFX selection ▪ Leverages command events for multiple purposes ▪ Reduces the M&S and data coordination requirements ▪ Reduces funding for duplicative M&S efforts

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Roles of 3CE

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3CE will:

- Support FCS program acquisition decisions.
- Enable EBCT mission readiness.
- Assess current capabilities to satisfy requirements; identify potential M&S solution providers and capability gaps.
- Integrate and configuration manage capabilities that are common across commands into the Bliss-WSMR LVC environment.
- Provide a means to collaborate cross-command and cross-domain capabilities.
- Establish and share a set of standards, best practices, and expertise.
- Provide a leave-behind capability for future analytic, training, and testing support to acquisition programs.

3CE will not:

- Replace a command's unique mission roles and responsibilities.
- Replace a command's unique M&S capabilities.
- Replace a command's unique data capabilities.
- Impose 3CE capabilities on command unique missions.
- Operate, maintain, or manage a command's distributed network.

As the integrator of an environment, 3CE focuses on common and consistent capabilities to enable cross command collaboration, synergy, and reusability.

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Scope of Current Effort

FUTURE COMBAT SYSTEMS
FCS
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3CE Environment

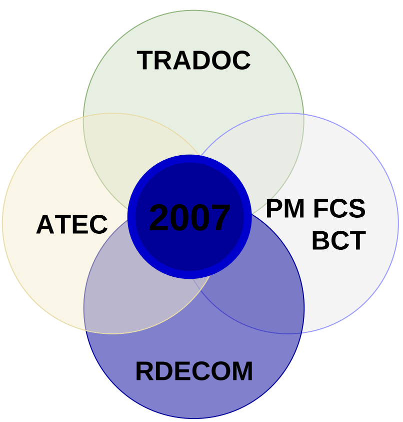
Expertise

Procedures | Data | Tools | Standards

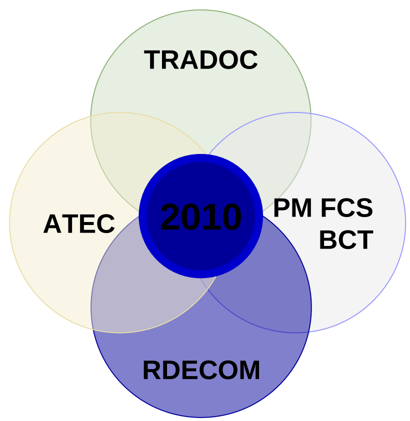
Network

A maturing 3CE environment … to endstate

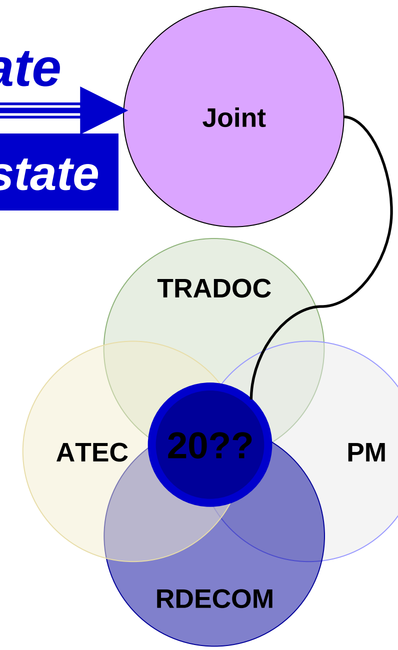
Near-Term



Mid-Term



Endstate



Execution Year Goal
Demonstrate and provide an initial environment as a proof of principle for potential users.

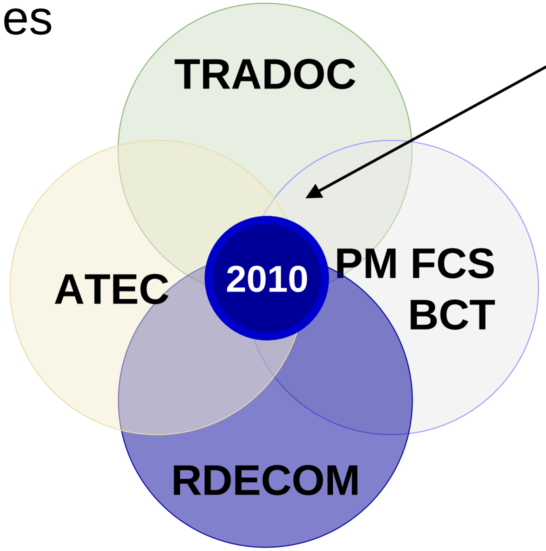
Interim Goal
Provide an environment for users at Bliss-WSMR to support FCS Core and Spinout activities.

End State
An M&S and data environment for design, development, integration, and test of SoS acquisitions.

The 2010 3CE Environment

- **Environment Context**
  - Support to EBCT activities at Bliss-WSMR.
  - Focused on common needs and required linkages
  - Established by 2010
- **Environment Components:**
  - Network
    - Persistent
    - Secure
    - Controlled Access
    - Performance/Characteristics
  - Tools
    - M&S
    - Analytic
    - Collaboration
  - Data
    - Characteristics and Performance
    - Operational
    - Terrain and Weather
  - Processes and standards

Focus of support for the 3CE environment



Activities	Users			
	Analysis		Test	Training
	SO2 FDTE	M-T-M	SO2 TFT	Mission
	Core Program	SO3	SO2 LUT	SO1 IOT/SO2
			SO1 IOT	Core Program

Summary

FUTURE COMBAT SYSTEMS
One Team-The Army/Defense/Industry

As the integrator of an environment, 3CE focuses on common and consistent capabilities to enable cross command collaboration, synergy, and reusability …

- Provides consistent representation through common tools and data IAW established standards and best practices.
- Provides the capability to leverage a single event for multiple purposes.
- Provides and develops environment capabilities that are traceable to user needs and design requirements.
- Enhances current M&S capabilities and reuse.
- Provides a leave behind capability to support future SoS acquisition programs.

By 2010, 3CE will have an instantiation of this capability to support user activities at Bliss-WSMR …

- Provides a core federation with supporting functional, interoperability, event management, and data collection and analysis tools.
- Provides an accessible knowledge repository that provides the processes, procedures, standards, and expertise to leverage 3CE capabilities.
- Provides a persistent and secure network that enables collaboration and interoperability across the commands and the LSI.

Approved for public release, distribution unlimited, TACOM 18 Apr 2007, FCS Case # GOVT 07- 7042

3CE Support to FCS

- **Working group lead for 3 parts of SO1 infrastructure**
  - M&S
  - Instrumentation
  - Data collection and Analysis
- **Responsible for technical integration of SO1 infrastructure**
  - Above 3 groups + Comms, Instrumentation, Threat
- **Provide infrastructure to support LSI distributed events**
  - Conduct
  - Capabilities
  - Lessons learned
- **Provide advisory for needed M&S capabilities**
  - Single face to the customer
- **LSI participates on equal basis with other advisory council members**
- **Covers acquisition lifecycle activities**

Experiment 1.1 Objectives and Description

FUTURE COMBAT SYSTEMS
One Team-The Army/Defense/Industry

- **Objective – Network and Spin Out 1 risk reduction and early hands-on feedback from Soldiers**
  - Engineering (material) risk reduction
  - Early input into Doctrine, Organization and Training

- **5 Key Objective Areas**
  - Network communications
  - Distributed fusion management
  - FCS interoperability
  - Information assurance
  - Progress and maturity of selected technologies

Supporting One Team Partners

BOEING SAIC From Science to Solutions GENERAL DYNAMICS Honeywell iRobot LOCKHEED MARTIN OVERWATCH SYSTEMS ORINCON DEFENSE TEXTRON Raytheon

Phase 1
Engineering Lab Experiment

C4ISR Lab - Huntington Beach, CA
- Hardware/Software Integration
- Systems Interoperability
- Mission Thread Checkout
- Interoperability Sub-experiments

SE2L – Ft Monmouth, NJ
- PKI/CDG/IDS Sub-Experiments

SoSIL - Huntington Beach, CA
- DFM Sub-Experiments

Jul – Oct 06

Phase 2
Engineering Field Experiment
WSMR, NM / Ft Bliss, TX

- Integration (RF and range infrastructure)
- Dry Runs
- Four Sub-experiments
  1. Radios and QOS,
  2. DFM
  3. Interop,
  4. Progress & Maturity

13 Soldier Observers

Sep – mid Dec 06

Phase 3
Tactical Field Demo
WSMR, NM / Ft Bliss TX

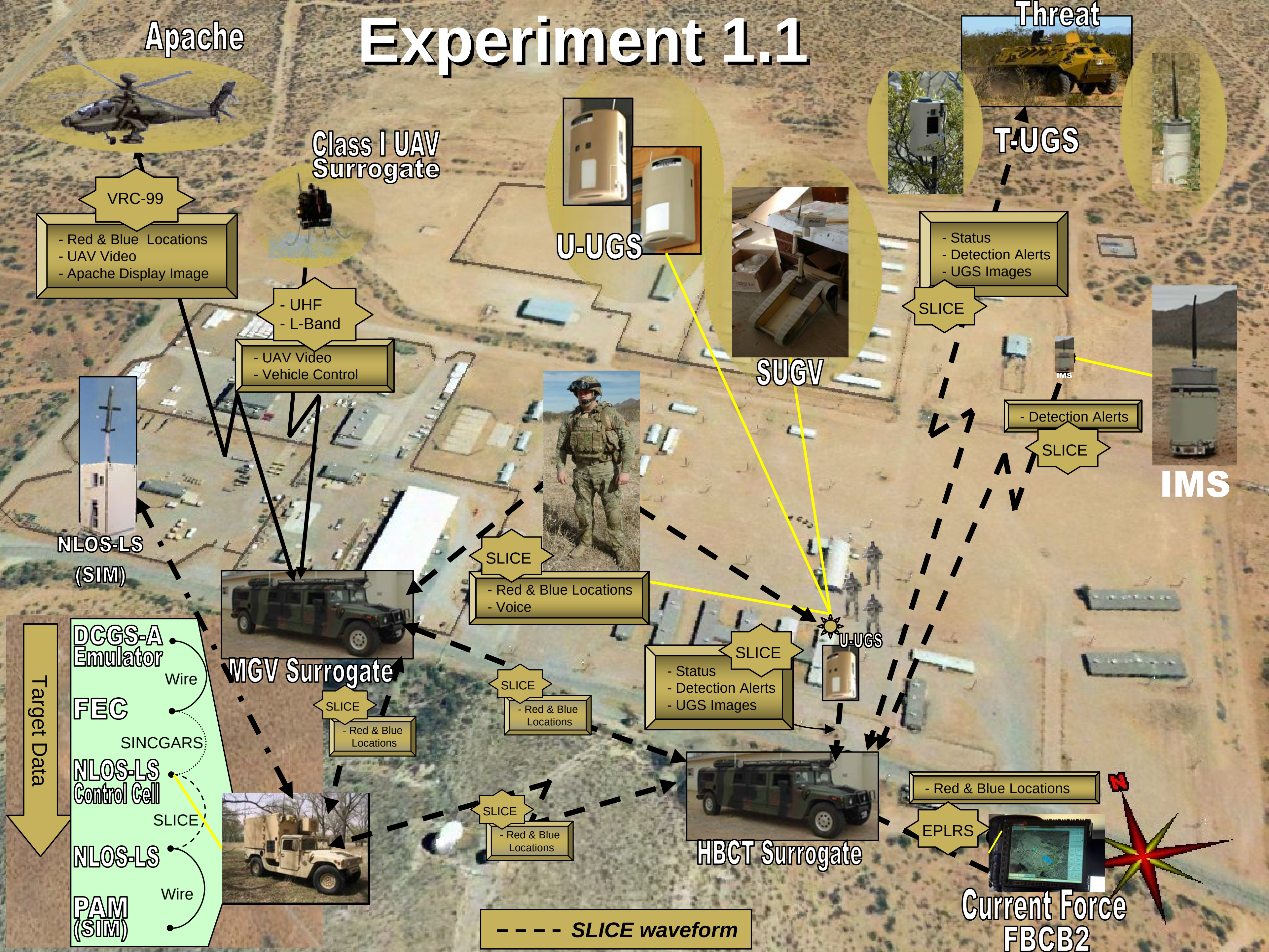
Phase 3A
- Soldier Orientation and Training
- Soldier Prep/Rehearsals
- INF PLT Collective Training Sim & Live
- Live Task Loading Sub-Experiment

Phase 3B
- VIPs onsite

36 Soldier Participants

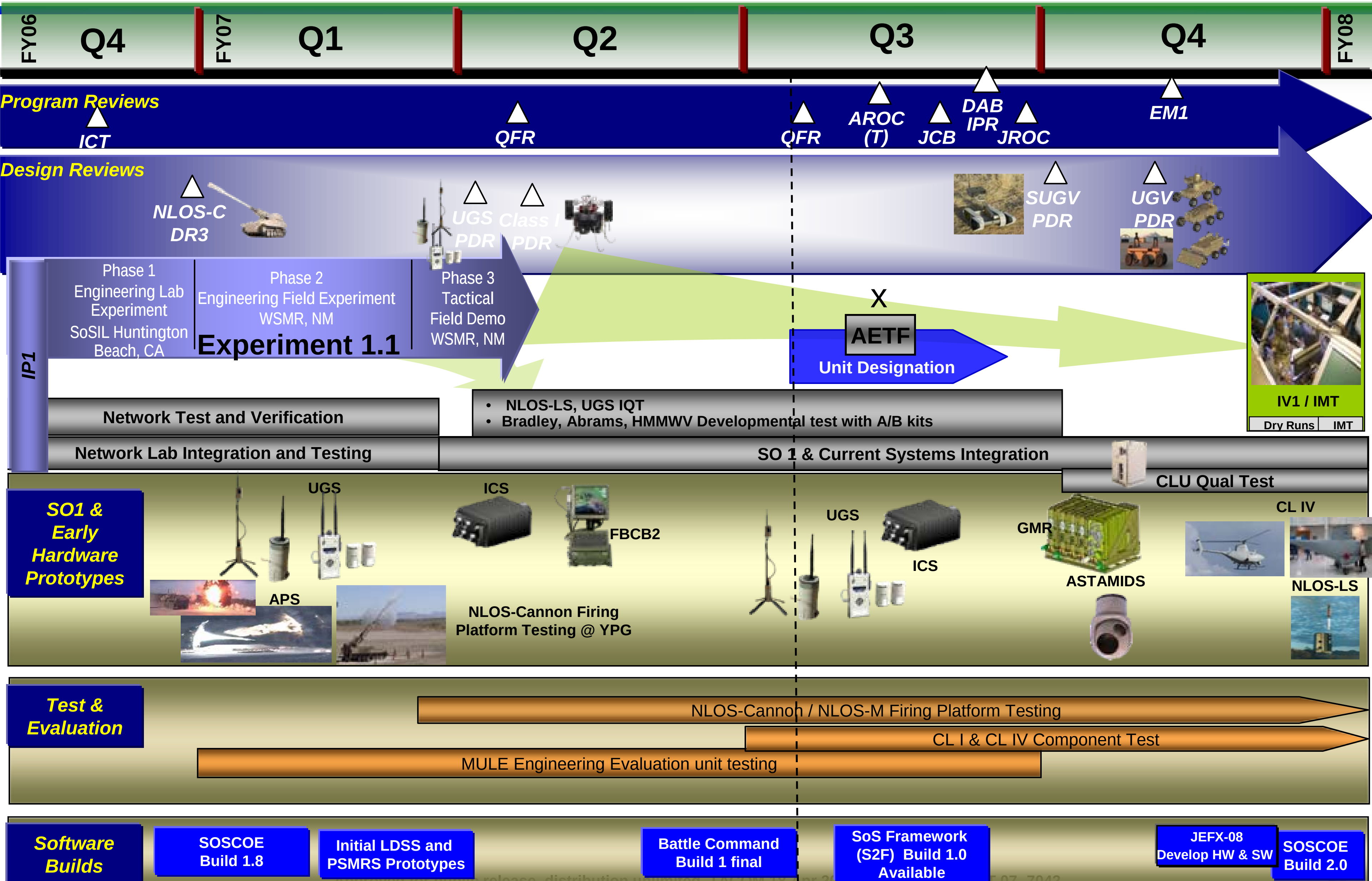
Jan – early Feb 07

Multi-purpose/multi-venue – technical, doctrinal and training impact



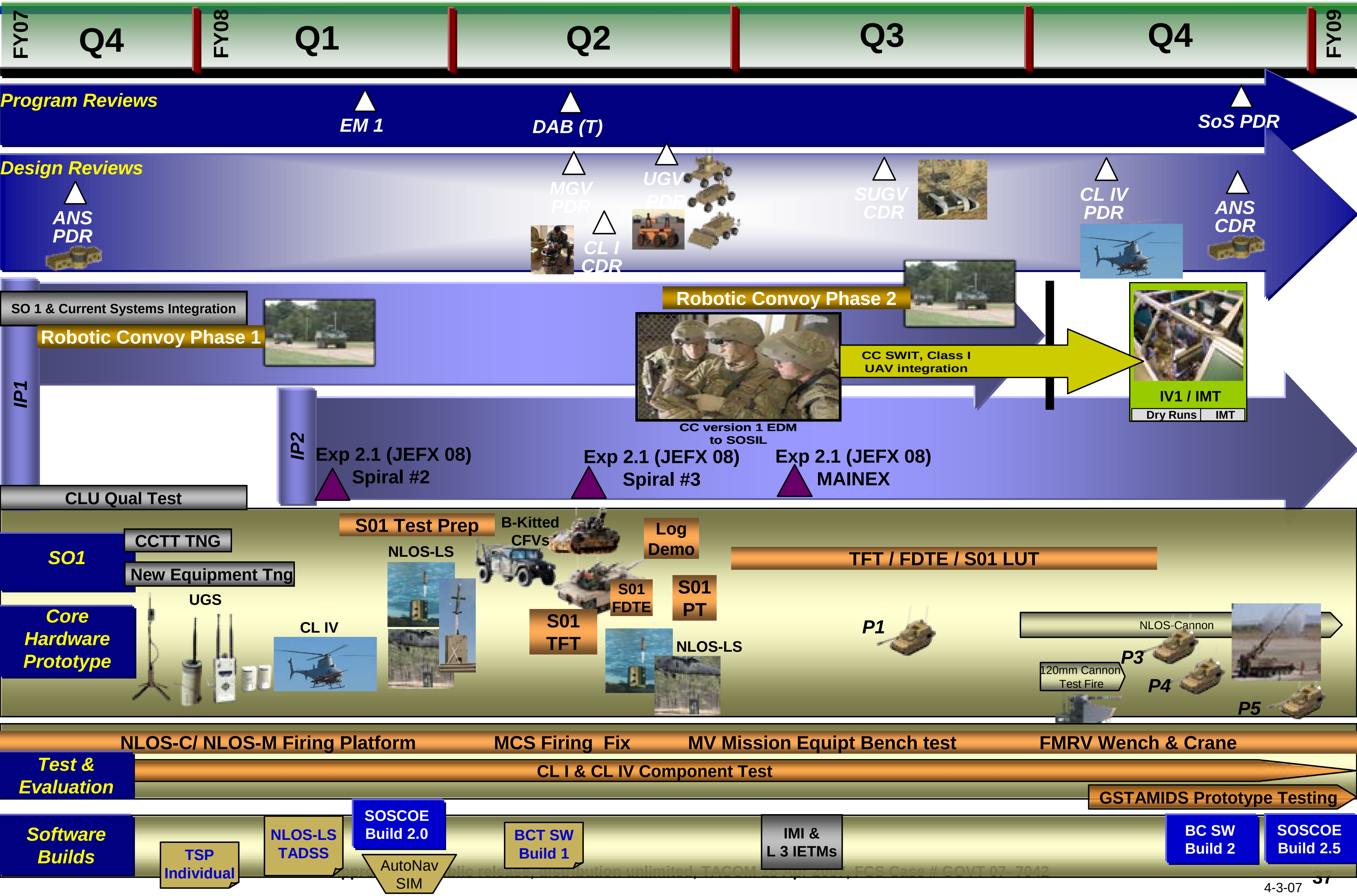
Experiment 1.1
Apache
VRC-99
- Red & Blue Locations
- UAV Video
- Apache Display Image
Class I UAV Surrogate
- UHF
- L-Band
- UAV Video
- Vehicle Control
U-UGS
SUGV
Threat
T-UGS
- Status
- Detection Alerts
- UGS Images
SLICE
IMS
- Detection Alerts
SLICE
IMS
NLOS-LS (SIM)
SLICE
- Red & Blue Locations
- Voice
MGV Surrogate
U-UGS
SLICE
- Status
- Detection Alerts
- UGS Images
SLICE
- Red & Blue Locations
SLICE
- Red & Blue Locations
SLICE
- Red & Blue Locations
HBCT Surrogate
- Red & Blue Locations
EPLRS
Current Force FBCB2
N
Target Data
DCGS-A Emulator
Wire
FEC
SINCGARS
NLOS-LS Control Cell
SLICE
NLOS-LS
Wire
PAM (SIM)
SLICE waveform

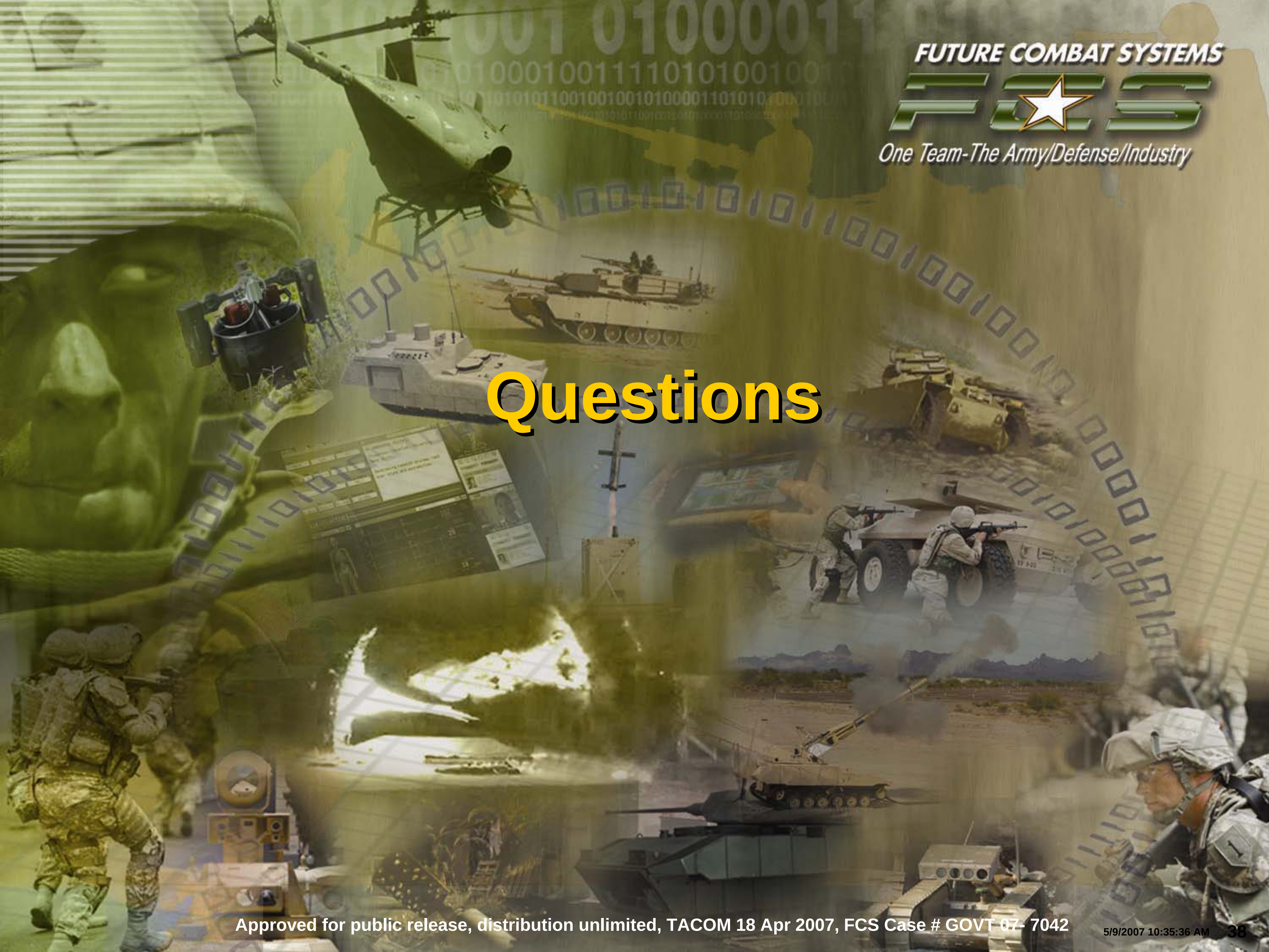
FY07 Objectives



Approved for public release, distribution unlimited, TACOM 18 Apr 2007, case # 07-7042

FY08 Objectives




FUTURE COMBAT SYSTEMS
FCS
One Team-The Army/Defense/Industry

Questions

FCS Technology Insertion and Transition Panel

DoD Technology Exposition

18 Apr 2007

Dr. Thomas H. Killion
Deputy Assistant Secretary for Research and Technology/ Chief Scientist

Science & Technology for a Campaign Quality Army with Joint & Expeditionary Capabilities

Current Force

~100 lb. load

Limited network

> 70 tons

< 10 mph

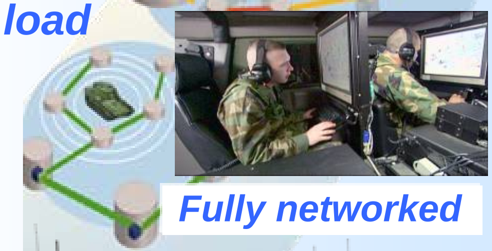
Enabling the Future Force

Science and Technology—
<u>develop and mature technology to enable transformational capabilities</u>
for the Future Modular Force
while <u>seeking opportunities to accelerate technology</u>
directly into the Current Modular Force

Enhancing the Current Force

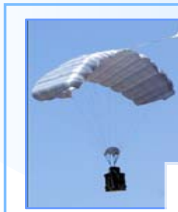
Future Force

< 40 lb. load



Fully networked

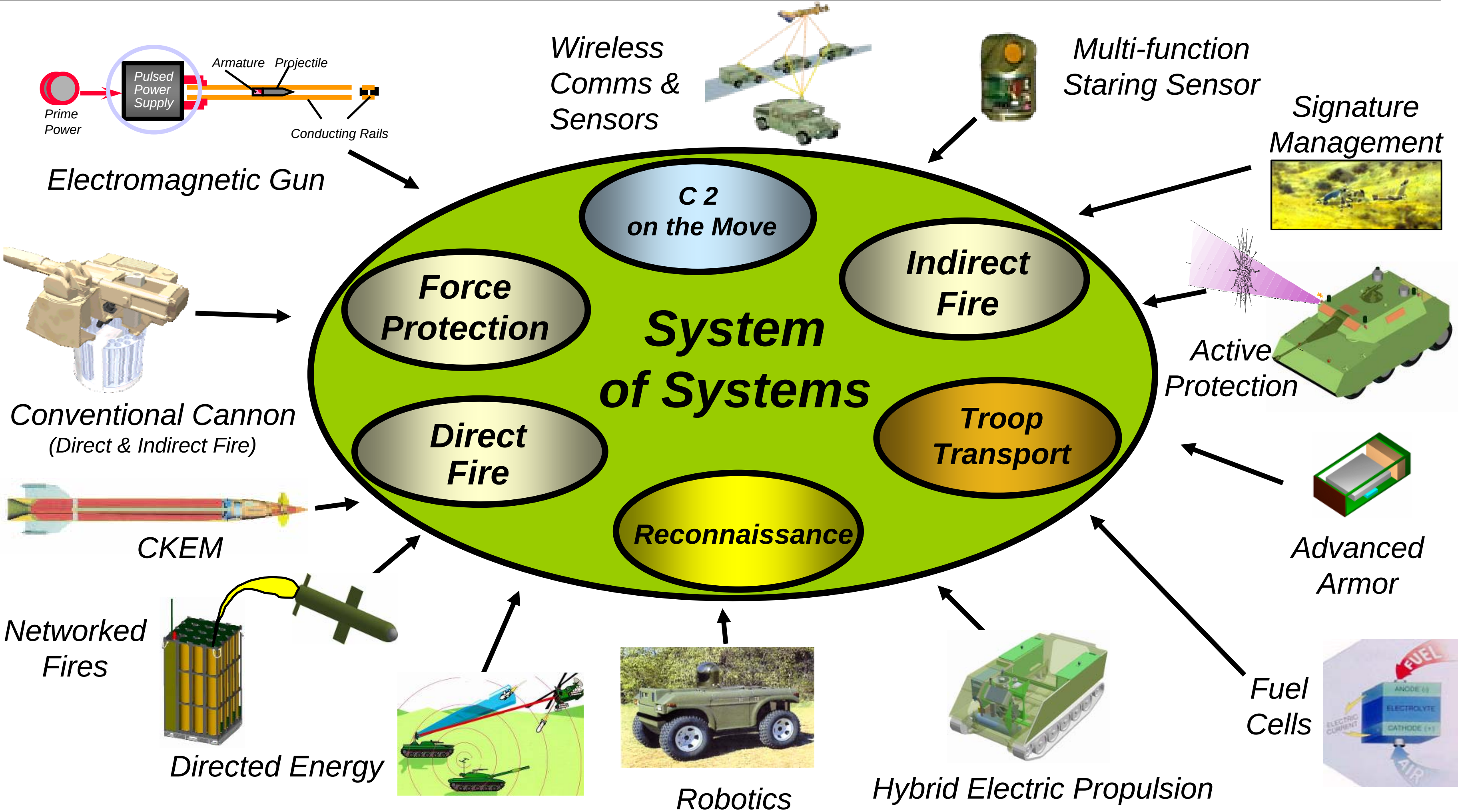
< 30 tons



> 40 mph

Increase Technology Options for FCS

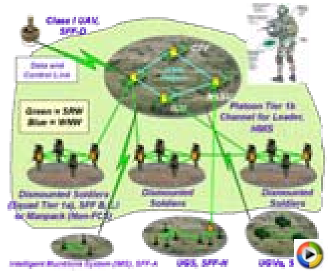
Mar 2001

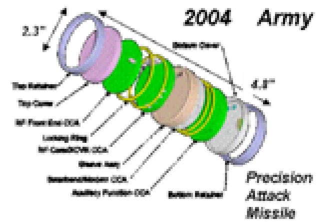


Focus on High Payoff Solutions for Technology Readiness Decision

Technology Options for FCS/ Future Force and the Current Force


Urban Reasoning & Battlespace Analysis

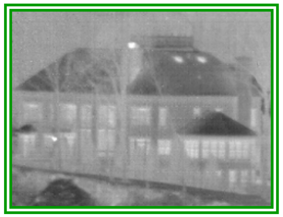

Soldier Radio Waveform



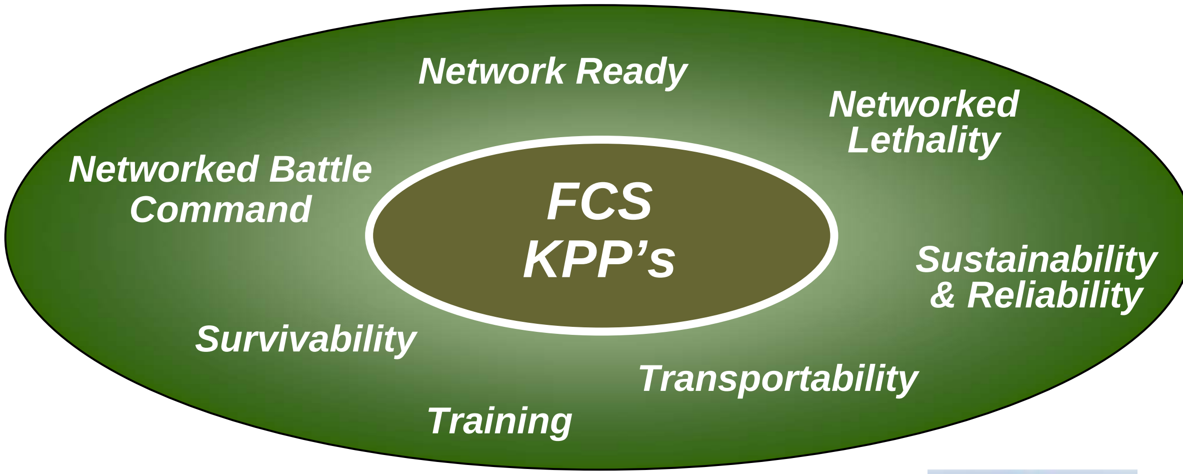
Networked Communications


Mid Range Munition (MRM)


Precision Attack Missile (PAM) Seeker

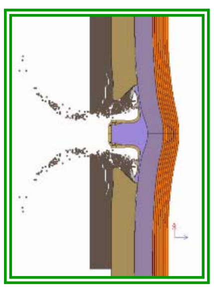

3rd Gen FLIR


Lightweight 120mm Gun



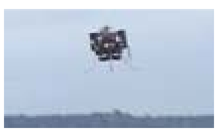

SATCOM On The Move (OTM)


Breech Loaded 120mm Mortar


Advanced Armor

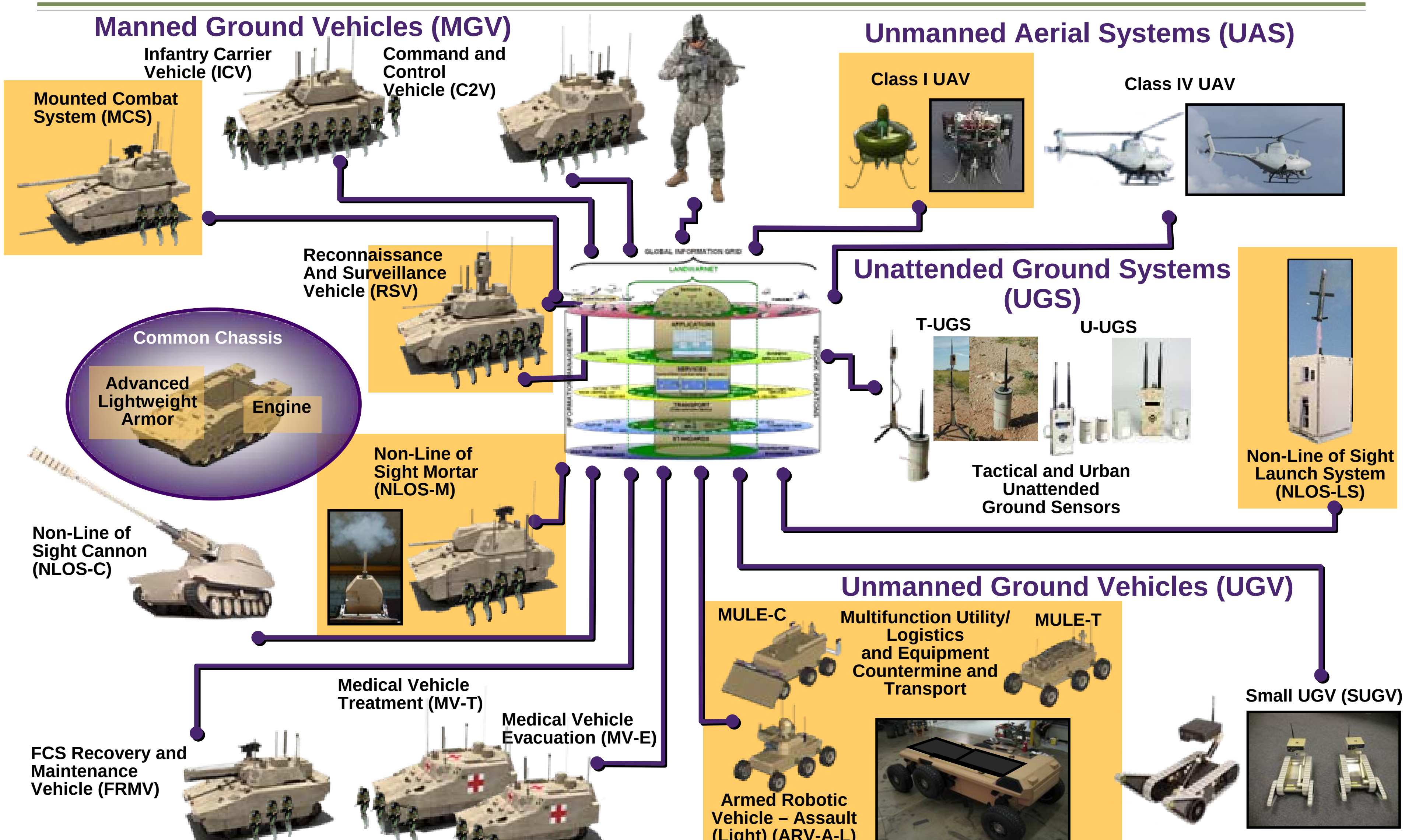

Unmanned Ground Vehicles (UGV)


UGV Crusher


Micro Air Vehicle (MAV)


Prototype Engine

FCS Brigade Combat Team



Army S&T…
Engine of Transformation

Australian Government
Department of Defence
Defence Science and
Technology Organisation

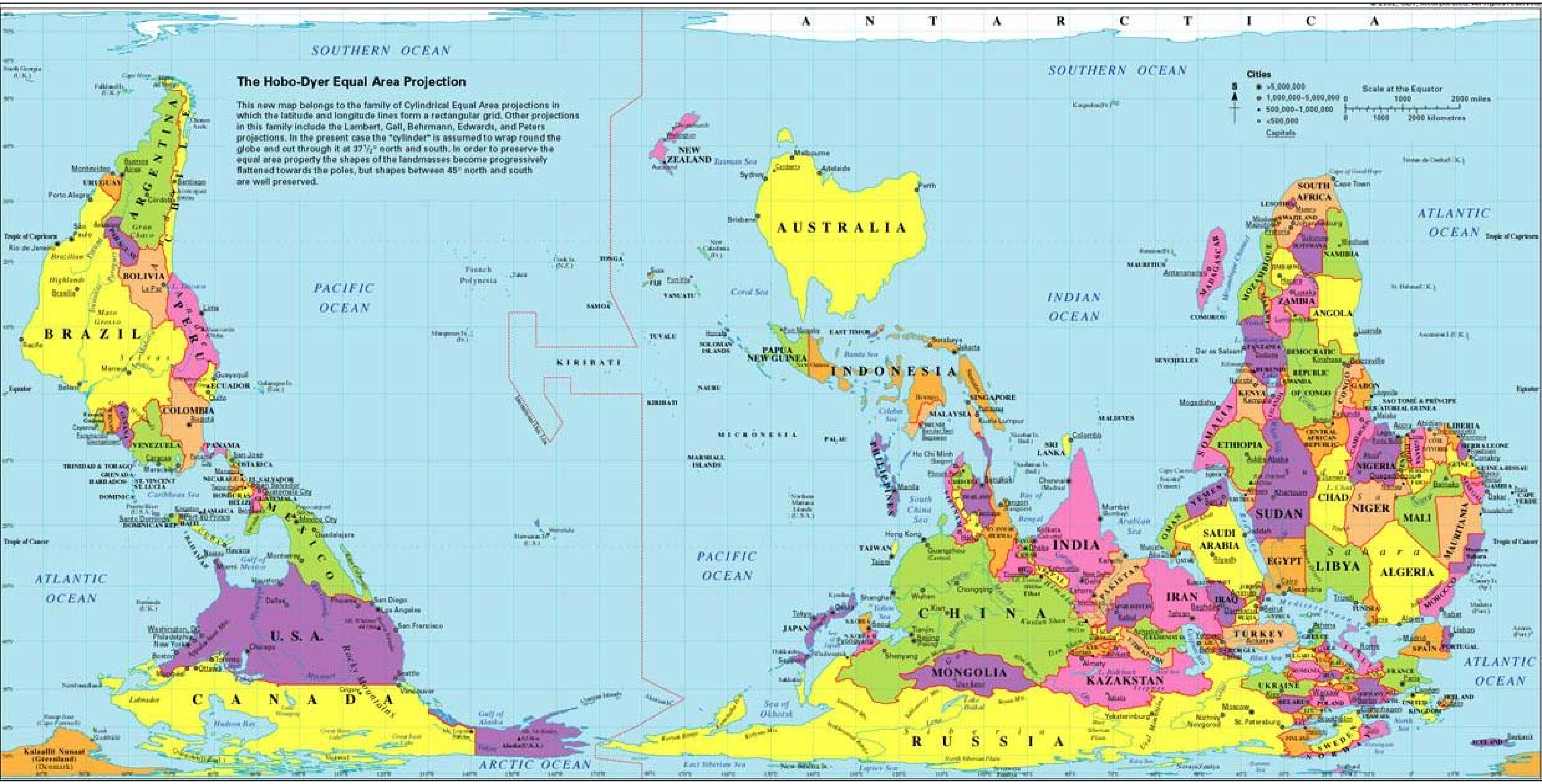
Coalition Partners Adaptation to Globalisation - A Perspective -

Dr A.C. (Tony) Lindsay
Counsellor, Defence Science
Embassy of Australia

April 19th 2007

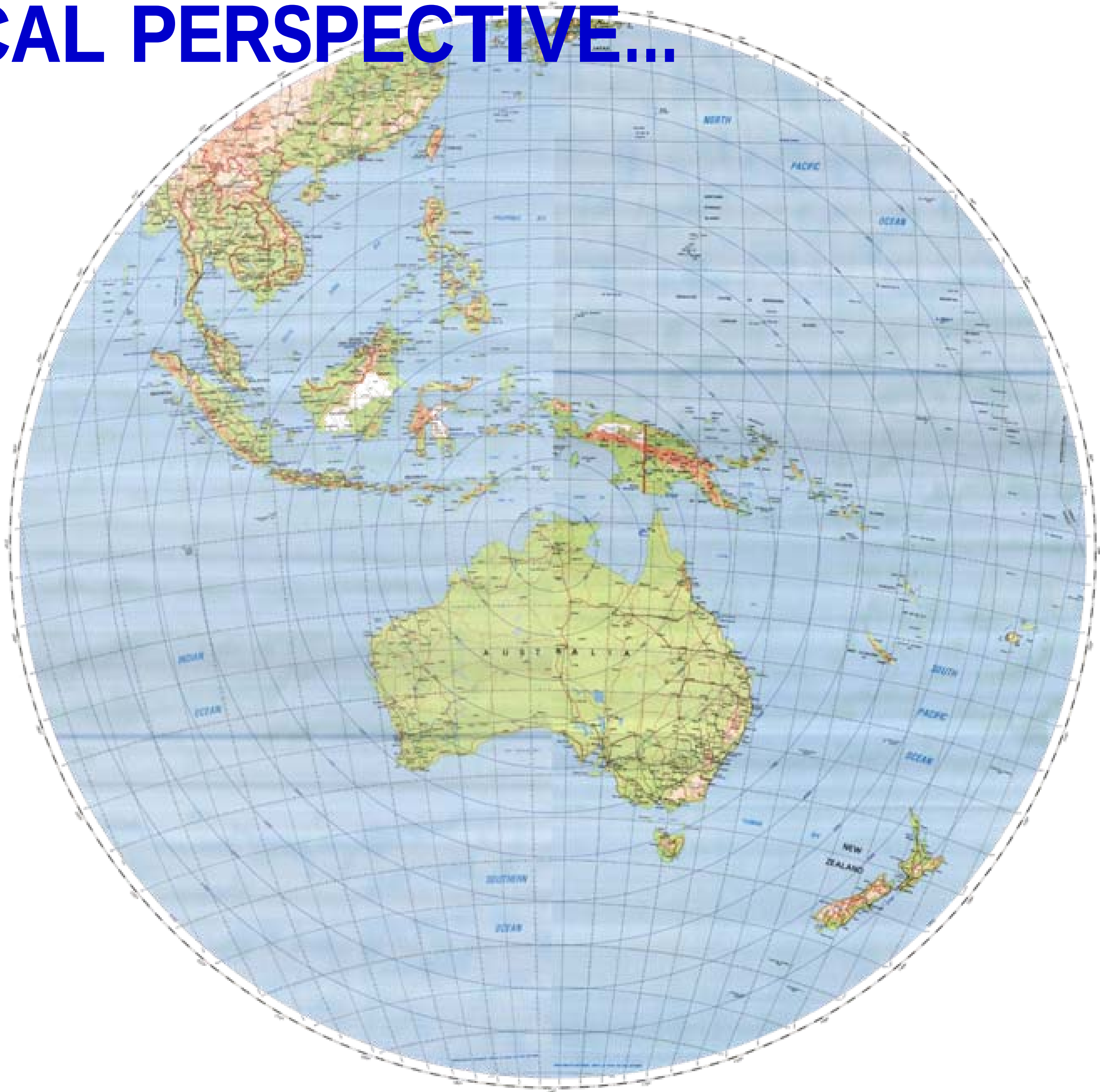
A DIFFERENT PERSPECTIVE...

Australian Government
Department of Defence
Defence Science and
Technology Organisation



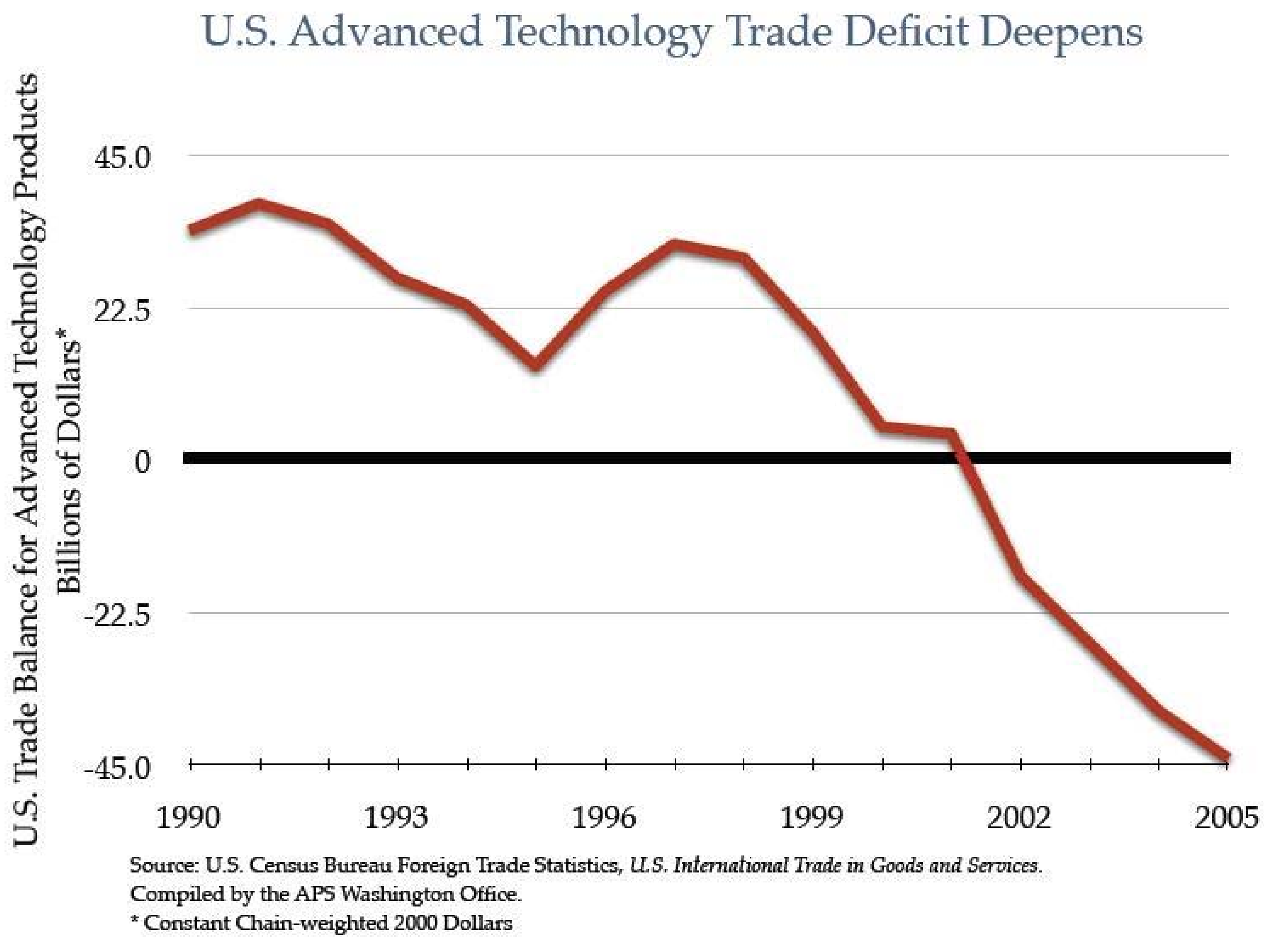
A LOCAL PERSPECTIVE...

Australian Government
Department of Defence
Defence Science and
Technology Organisation



GLOBALISATION OF TECHNOLOGY...

Australian Government
Department of Defence
Defence Science and
Technology Organisation



From: Task Force on the Future of American Innovation, November 2006 (www.futureofinnovation.org/2006report/)

UK's DCDC STRATEGIC TRENDS 2007-2036 (1)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Key areas of S&T Impact:

- Sensor and network technologies
- New energy technologies
- Cognitive Science
- Nanotechnology
- Biotechnology
- ICT

Extracts from the UK MoD's Development, Concepts and Doctrine Centre's Global Strategic Trends 2007-2036, pp 56-66.

UK's DCDC STRATEGIC TRENDS 2007-2036 (2)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Key areas of S&T Risk:

- Uncertainty
- Unintended consequences
- Technology dependence
- Information explosion
- Narrowing technological advantage
- The role of AI
- Authenticity of information
- Erosion of civil liberties
- Ethical challenges
- Inequality

Extracts from the UK MoD's Development, Concepts and Doctrine Centre's Global Strategic Trends 2007-2036, pp 56-66.

UK's DCDC STRATEGIC TRENDS 2007-2036 (3)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Defence Implications:

- Information warfare;
- Encryption – reduction in indicators & warnings; commercial implications of quantum computing;
- Technology leakage – incl. via "ethical scientists";
- Defence R&D – following COTS, partnerships, increasing globalization;
- Rapid obsolescence;

Extracts from the UK MoD's Development, Concepts and Doctrine Centre's Global Strategic Trends 2007-2036, pp 56-66.

UK's DCDC STRATEGIC TRENDS 2007-2036 (4)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Defence Implications:

- Defence niches – will be maintained however;
- Ethical intervention – increasing;
- Wider availability of affordable technology;
- Rapid mobilisation – ICT-enabled "Flashmobs";
- Unmanned technologies – increasing legal & ethical issues

Extracts from the UK MoD's Development, Concepts and Doctrine Centre's Global Strategic Trends 2007-2036, pp 56-66.

CONFLUENCE AND DYNAMICS (1)

Australian Government
Department of Defence
Defence Science and Technology Organisation

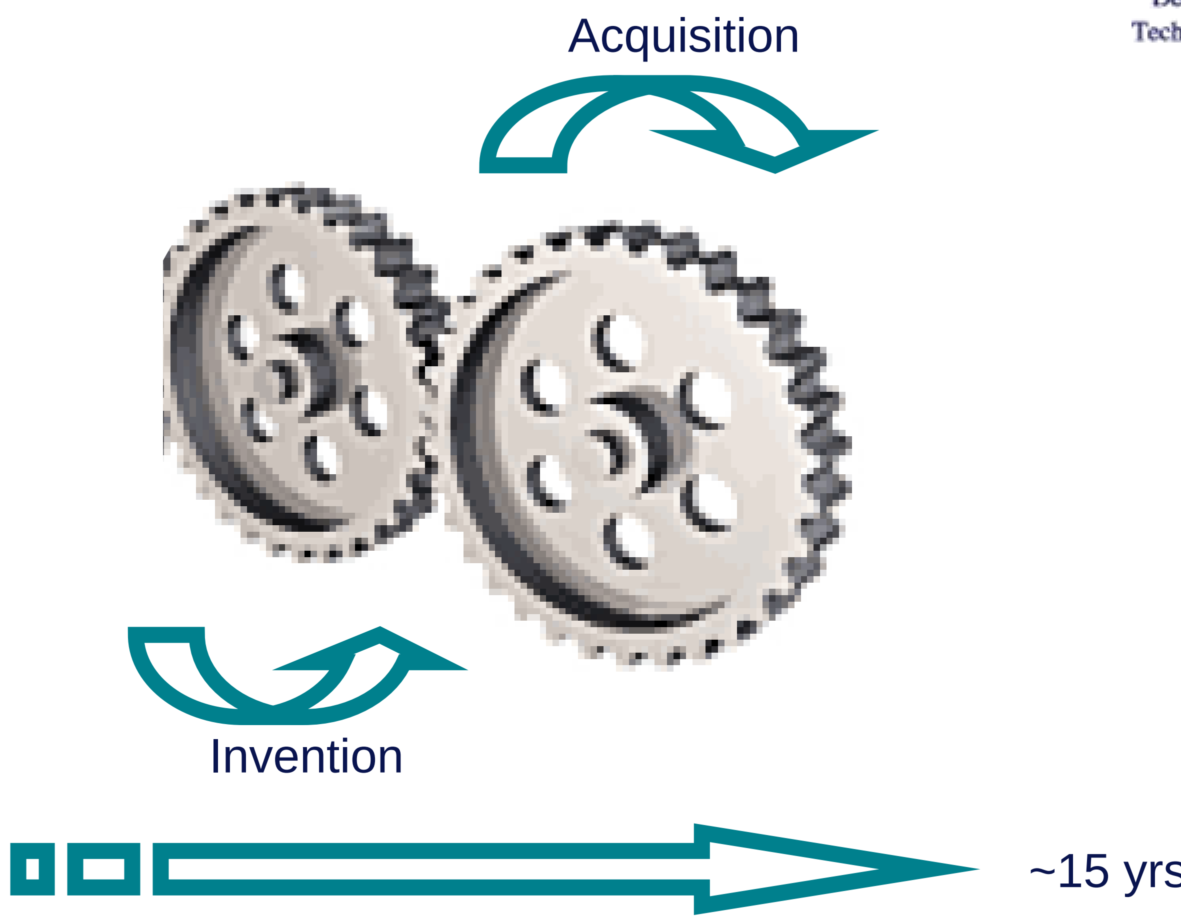
- The "dynamic" of a technology typically follows the well-known "S"-curve;

- Current and near-term trends are due to a confluence of only two technologies - we're living in a time dominated by the confluence of electronics & photonics → an era where we're exploiting "classical quantum";

- This confluence is both an enabler for changing dynamics (knowledge diffusion), and potentially a catalyst for new confluences (e.g. bioelectronics, cognitive electronics, ...)

CONFLUENCE AND DYNAMICS (2)

Australian Government
Department of Defence
Defence Science and Technology Organisation

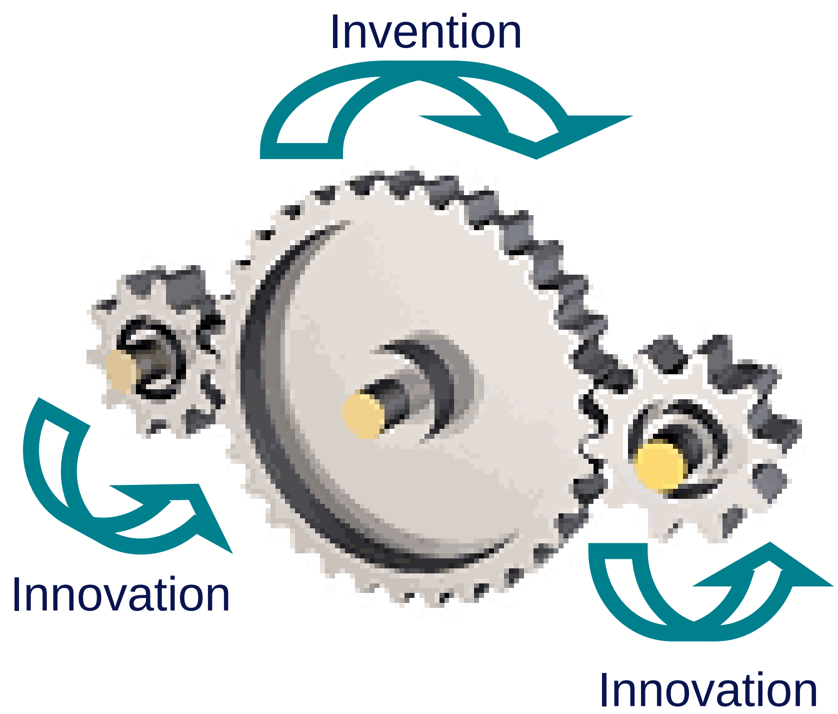


The old Defence paradigm – an invention cycle and an acquisition cycle

GIF from http://www.sevenoaksart.co.uk/Sevenoaks_Art_metal.htm

CONFLUENCE AND DYNAMICS (3)

Australian Government
Department of Defence
Defence Science and Technology Organisation



A new reality – an invention cycle driving **multiple innovation cycles** with negligible (or integrated!) acquisition cycles

GIF from http://www.sevenoaksart.co.uk/Sevenoaks_Art_metal.htm

COMPONENTS OF THE INNOVATION CYCLE (1)

Australian Government
Department of Defence
Defence Science and Technology Organisation

TECHNOLOGIES

- Low(er) barrier to entry;
- Increasing international capabilities (education, information access, investment, ...);
- Ubiquitous technology (computing, comms, electronics, ...) enabled through dual use technologies and the opening up of societies and markets (Friedmann's 3rd Convergence, 3 billion new consumers – a market magnet, so it won't stop...);

COMPONENTS OF THE INNOVATION CYCLE (2)

Australian Government
Department of Defence
Defence Science and Technology Organisation

TRANSITION

- “Fit for purpose”, not MILSPEC;
- Focused problems, using ubiquitous technologies (eg wireless) – leads to multiple innovation cycles exploiting same basic “pool” of technologies...
- Tactics, Techniques & Procedures replace static standards

  $\Rightarrow$ which means learning by doing is key;

  $\Rightarrow$ not “train as you fight”, but “innovate to fight”

COMPONENTS OF THE INNOVATION CYCLE (3)

Australian Government
Department of Defence
Defence Science and Technology Organisation

PROCESSES

- Minimal, outcome focused, results driven; risk management, not risk avoidance;
- Tight feedback loop to technology and TTP innovation - it's all done at "the speed of need" (GEN Cartwright);
- There is an intrinsic "size" factor at play (it's easier to equip 20 people than 20000);
- Regulations/policy will not keep up with innovation (e.g. cyber now) $\Rightarrow$ asymmetric policies enhance impact & likelihood of asymmetric threats

WHAT IT MEANS FOR COALITION NATIONS (1)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Looking “outwards” (i.e. from the Coalition)

- We face the same threats, issues, ...

WHAT IT MEANS FOR COALITION NATIONS (2)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Looking "inwards" (i.e. towards the US as a partner)

- For exactly the same reasons that drive the increasing threat, the potential to contribute is greater than ever before;

- Potential to better focus resources (share knowledge of priority threats) – US supplies the global "context" for targeted innovation

WHAT IT MEANS FOR COALITION NATIONS (3)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Looking "inwards" (i.e. towards the US as a partner)

- The threat sets will continue to change, increasing emphasis on "soft power"† – addressing these problems will benefit from different cultural viewpoints (e.g. social network analysis, cyber);

† - discussed in the UK MoD's Development, Concepts and Doctrine Centre's Global Strategic Trends 2007-2036.

WHAT IT MEANS FOR COALITION NATIONS (4)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Looking “inwards” (i.e. towards the US as a partner)

- Policy settings will determine whether the opportunities are realized e.g.

⇒ releasability directly impacts the “value” of the problem to be addressed;

⇒ Berry Ammendment-like issues will determine the manner in which solutions can flow back to the US.

CONCLUSIONS

Australian Government
Department of Defence
Defence Science and Technology Organisation

- Technology globalisation is inevitable and unstoppable;
- It will erode technology leadership;
- The innovation cycle will be as important as the invention cycle, but it's not just technology – TTPs & processes need to be included;
- The problem set will become more complex, not less, and be driven by other than "traditional" factors (or, traditional factors driven by new contexts);
- Strength and security assurance will arise through partnerships – "global reach" is not just a kinematic capability.

THANK YOU FOR YOUR ATTENTION

Australian Government
Department of Defence
Defence Science and Technology Organisation

Contact Details:
Dr Tony Lindsay
Ph: 202 797 3353
Email: tony.lindsay@defence.gov.au

International Technology Cooperation

Dr Tony Sinden

Defence Science and Technology Counsellor, British Embassy

Outline

- **Why Collaborate**

- **How to Collaborate**

Why Collaborate?

Why Collaborate?

More effective pursuit of military goals

More capable national equipment

More capable Allies

Coalition technological interoperability

Collaborative Development & Procurement

Access to new **TECHNOLOGY**

Access to new **EXPERTISE**

Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

Collaboration is not new…

- In October 1957 UK and US committed to cooperate on Defense Science and Technology for "mutual benefit"
- Subsequently joined by Canada, then Australia and New Zealand to form – The Technical Cooperation Program
- Not the only collaboration but one of the most enduring and approaching its Fiftieth Anniversary in October 2007…

The Technical Collaboration Program

The 50th Anniversary Meeting has the theme of
"A Stable Partnership in a Changing World"
with the recently approved Banner Statement of:

TTCP will develop, share and integrate emerging defense science and technology to <u>advance the military capabilities</u> of the five member nations. TTCP will provide a <u>trusted, productive and creative network</u> that allows us to develop our <u>best people</u>, advance our <u>best ideas</u> and make full use of our <u>collective opportunities</u>.

Why Collaborate?

More effective pursuit of military goals

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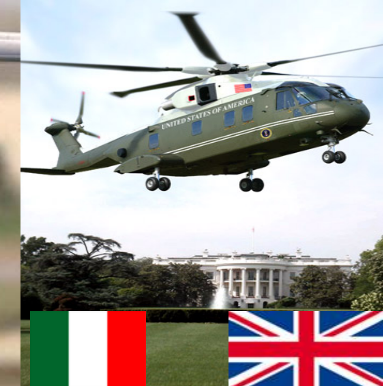


US benefits
from
overseas
equipment
development






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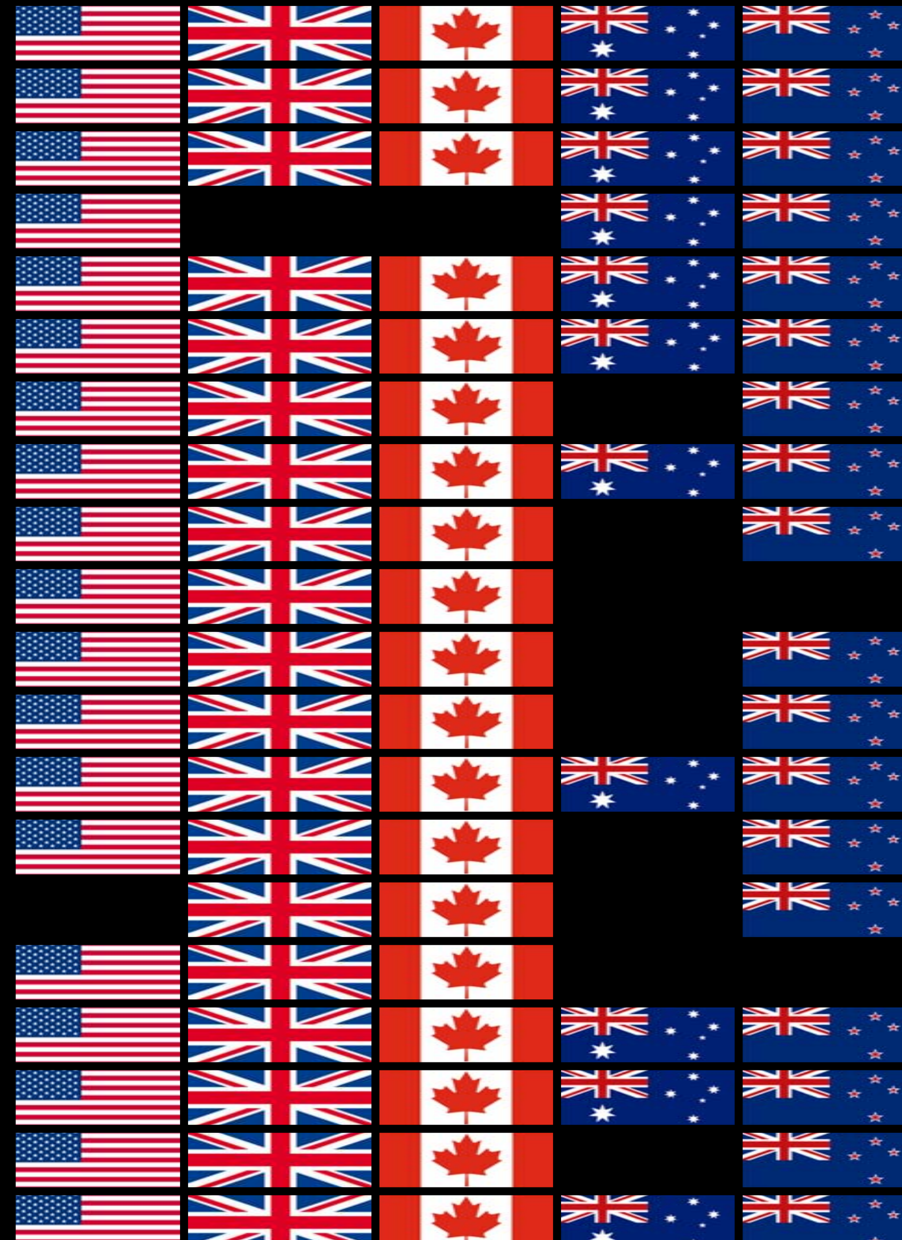
Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

Examples of Coalition Operations

WWII
Cold War
Korea
Vietnam
Kuwait/Iraq (Desert Shield)
Kuwait/Iraq (Desert Storm)
Kuwait/Iraq (UNIKOM)
Somalia
Former Yugoslavia (UNPROFOR)
Georgia
Former Yugoslavia (IFOR)
Kosovo
East Timor
Liberia
Sierra Leone
Mediterranean (Active Endeavour)
Afghanistan (Enduring Freedom)
Afghanistan (ISAF)
Bosnia & Herzegovina (SFOR II)
Iraqi Freedom



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Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

We operate
side-by-side
around the world

Iraq - 2003

1 Marine Expeditionary Force

3 Commando Brigade

15 Marine Expeditionary Unit

Why Collaborate?

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Access to new **TECHNOLOGY**

Access to new **EXPERTISE**

Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

Top National Research Priorities

					
Automation & Unmanned Systems	X	X	X	X	X
CBR Mitigation	X	X	X	X	X
Combat Identification	X	X	X		
Counter-IED	X	X	X	X	X
Force Protection	X	X	X	X	X
Hard & Buried Targets	X	X			
ISR	X	X	X	X	X
Modelling & Simulation	X	X	X	X	
Nanotechnology	X	X	X		
Networks & IT	X	X	X	X	X
Through-Life Costs	X	X	X	X	X
Urban Operations	X	X	X	X	

Implications for:

- Government program managers – other people are working on the same problems as you…
- Industry managers – there are other markets for your ideas…

Why Collaborate?

More effective pursuit of military goals

More capable national equipment

More capable Allies

Coalition technological interoperability

Collaborative Development & Procurement

Access to new **TECHNOLOGY**

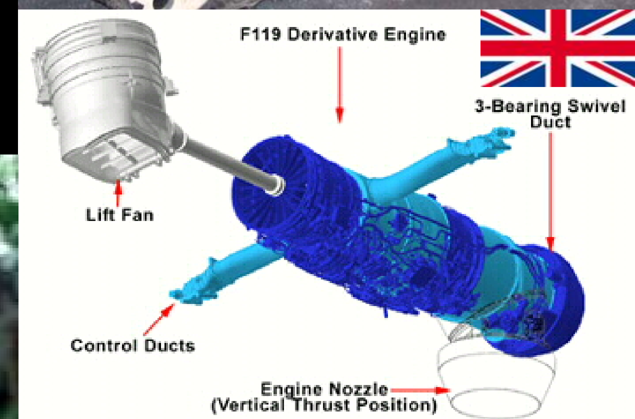
Access to new **EXPERTISE**

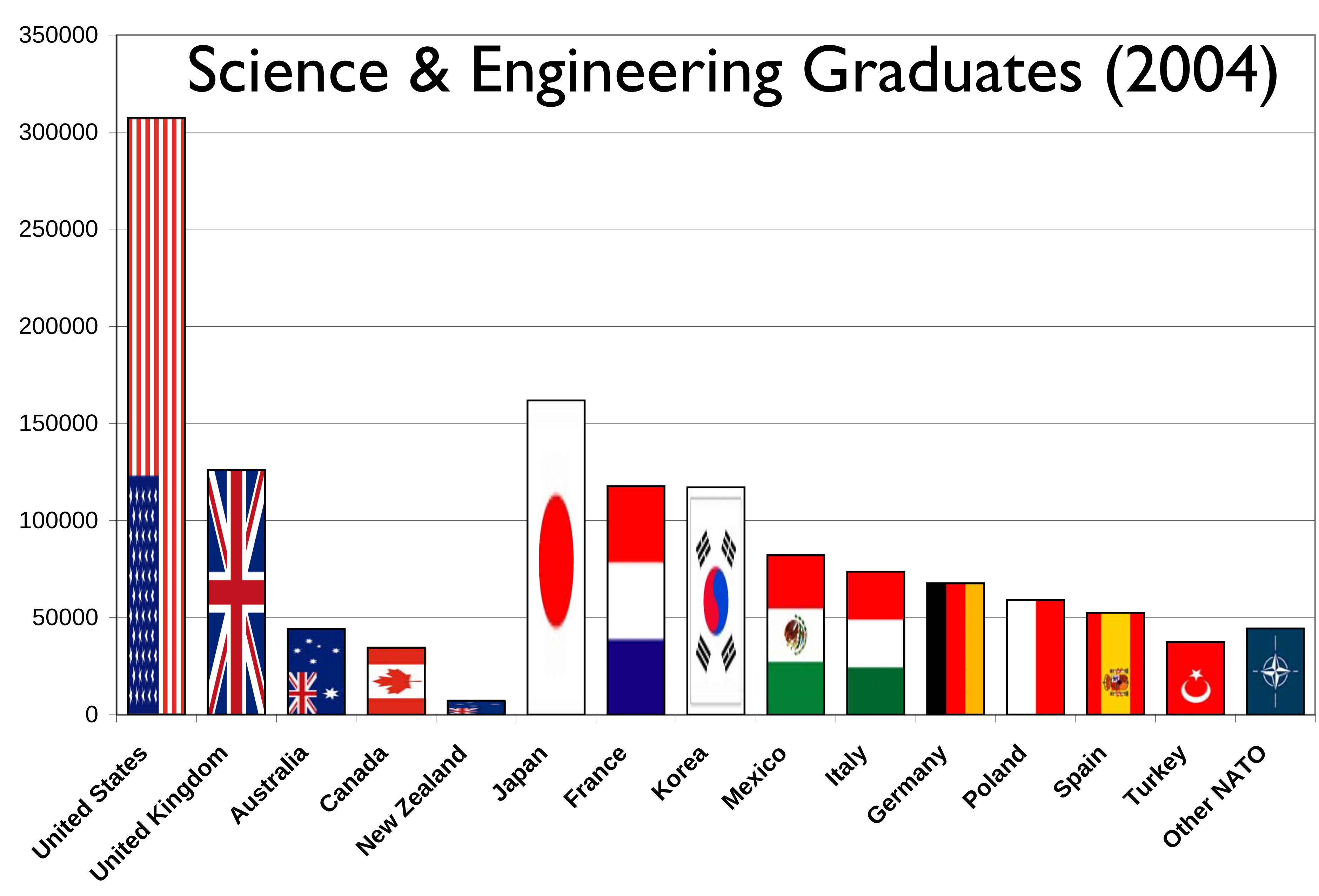
Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

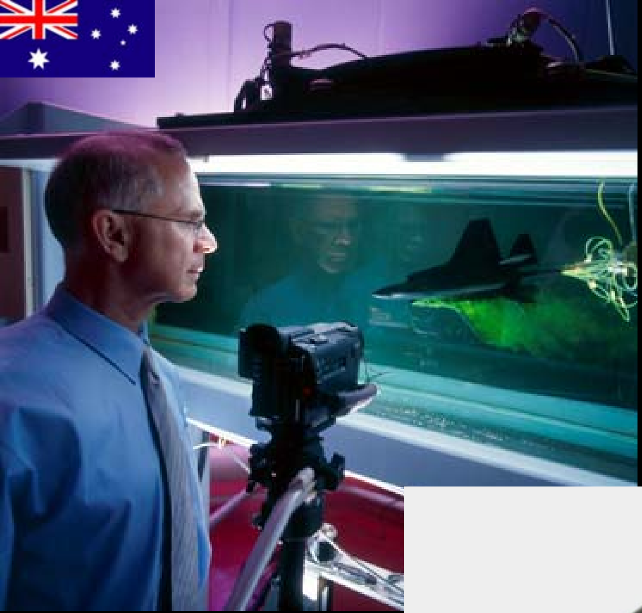
PROVIDED THROUGH COLLABORATION

US benefits from overseas technology





Data Sources: http://stats.oecd.org/wbos/default.aspx?DatasetCode=RGRADSTY



US benefits from overseas facilities

Why Collaborate?

More effective pursuit of military goals

More capable national equipment

More capable Allies

Coalition technological interoperability

Collaborative Development & Procurement

Access to new **TECHNOLOGY**

Access to new **EXPERTISE**

Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

Relationships

Established relationships between TTCP scientists enables each nation individually and collectively to tackle the threats we all face in Iraq, Afghanistan and elsewhere.

Why
rate?

More effective pursuit of military goals

More capable national equipment

More capable Allie

OR – SHARED RESEARCH & DEVELOPMENT COSTS FOR MUTUAL BENEFIT

T

ew
ERTISE

Access to new
FACILITIES

Long-term personal
RELATIONSHIPS

ROVIDED THROUGH COLLABORATION

Outline

- **Why Collaborate**
- **How to Collaborate**

How to Collaborate

US Program

US Government

US Industry

Allied Program

Allied Government

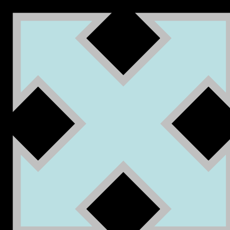
Allied Industry

Government – Government

Sources of Information (for US Government staff):

- **US National Representatives to collaborative fora** (e.g. TTCP, NATO) – for advice on Allied programs and collaborative channels
- **Overseas US S&T Staff** – for advice on Allied programs, collaborative channels and processes
- **DDR&E International Technology Programs staff** – for advice on collaborative channels and processes
- **DoD International Agreements staff** – for advice on collaborative processes
- **Defense S&T staff in Allied Embassies** – for advice on Allied programs, collaborative channels and processes

How to Collaborate

US Program		**Allied Program**
US Government		Allied Government
US Industry		Allied Industry

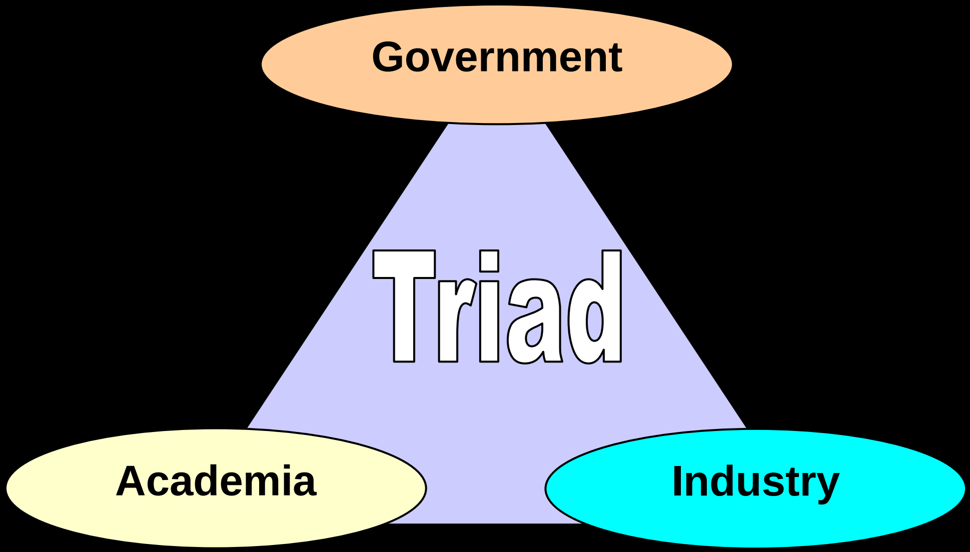
Multinational Government–Industry Partnership, e.g. JSF, Network & Information Sciences International Technology Alliance

ITA Overview

- UK MOD - US Army
- Consortium, led by IBM
- Fundamental research in **Network and Information Sciences**
- Transition results
- A 5 year, $58M, research programme started in May 06
- Builds on the success of UK Defence Technology Centres and US Army Collaborative Technology Alliances

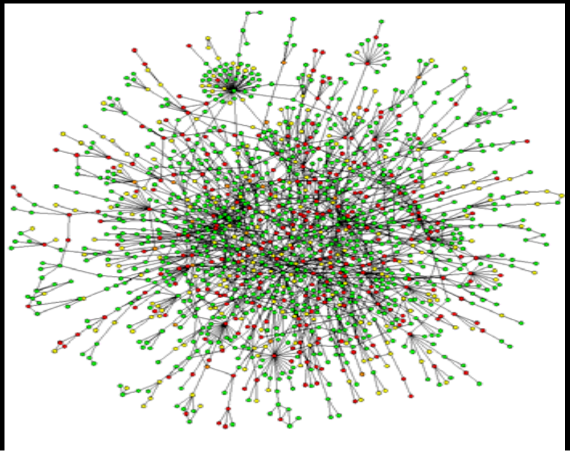
The ITA Concept

- Long-term research and Innovation
- Applied research and Exploitation
- Defence relevance
- International Research Collaboration
- The Alliance



Objectives

- Research and evaluate affordable state-of-the-art technologies
- Design in interoperability
- Promote collaboration between leading industrial and academic organisations in both nations
- Close working between consortium and government



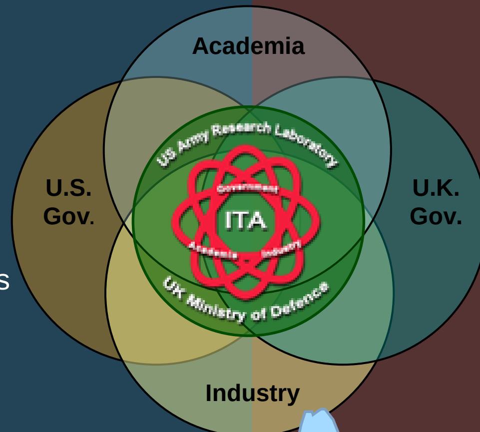
Process

- Government-Government talks on principles
- Open competition
- Proposals evaluated by joint government team
- Government-Government Project Arrangement
- Awards made to successful consortium
  - Fundamental Research Component
    - US award instrument (on behalf of both nations)
    - Consortium cost-sharing was not required, but was offered
  - Technology Transition Component
    - Separate US and UK award instruments

Consortium

ACADEMIA

1. Carnegie Mellon University
2. City University of New York
3. Columbia University
4. Pennsylvania State University
5. Rensselaer Polytechnic Institute
6. University of California Los Angeles
7. University of Maryland
8. University of Massachusetts

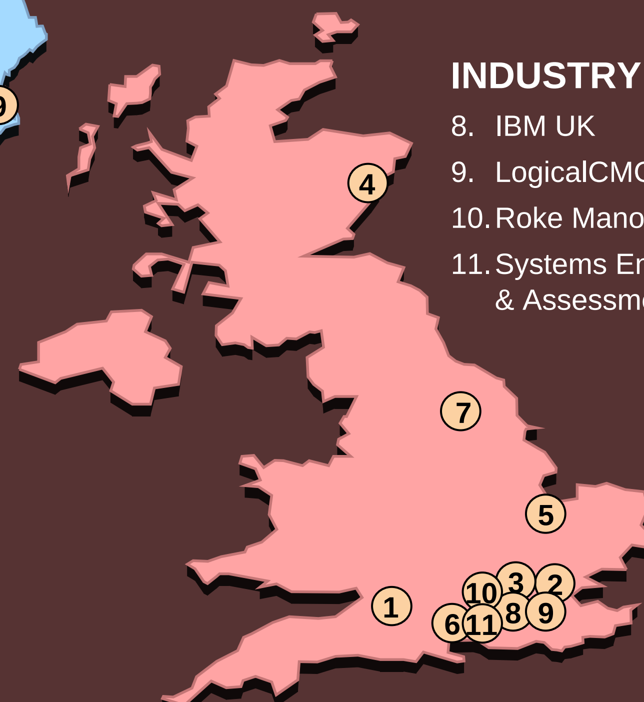


ACADEMIA

1. Cranfield University, Royal Military College of Science, Shrivenham
2. Imperial College, London
3. Royal Holloway University of London
4. University of Aberdeen
5. University of Cambridge
6. University of Southampton
7. University of York

INDUSTRY

9. BBNT Solutions LLC
10. The Boeing Corporation
11. Honeywell Aerospace Electronic Systems
12. IBM Research
13. Klein Associates



INDUSTRY

8. IBM UK
9. LogicalCMG
10. Roke Manor Research Ltd.
11. Systems Engineering & Assessment Ltd.

Technical Programme

- Consortium Technical Activities
  - 4 technical areas
  - 12 projects
- Each Project :
  - One Project Champion
  - Researchers from Academia, Industry, Government
  - Spans multiple technical areas

Network Theory

Security across a System of Systems

Sensor Information Processing & Delivery

Distributed Coalition Planning & Decision Making

Project Champion

UK University

US University

MoD/Dstl

ARL

UK Industry

US Industry

Industry – Industry

Sources of Information (for US Industry staff):

- **Allied S&T Managers** – for advice on Allied programs and opportunities
- **Overseas US S&T Staff** – for advice on Allied programs, opportunities and processes
- **Allied Contracts Bulletins, etc.** – for advice on Allied programs and opportunities
- **Defense S&T staff in Allied Embassies** – for advice on Allied programs and processes

Questions?

OR

LUNCH?

For further information please contact:

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Washington
DC 20008

tony.sinden@bdsus.mod.uk
Phone: +1 202 588 6723

DoD Basic Research Program with a Focus on Academia

National Defense Industrial Association
8th Annual Science & Engineering
Technology Conference
North Charleston, SC.

Dr. William S. Rees, Jr.
Deputy Under Secretary of Defense
(Laboratories and Basic Sciences)
17 April 2007

OUTLINE

- DoD Funding and Priorities
  - Emphasis on Basic Research
- Strategic Planning
- National Defense Education Program
  - Relationship to DoD future workforce
  - National Security Science and Engineering Faculty Fellowships
  - Science and Engineering Enrichment
    - Materials World Modules
    - Pre-Engineering Modules

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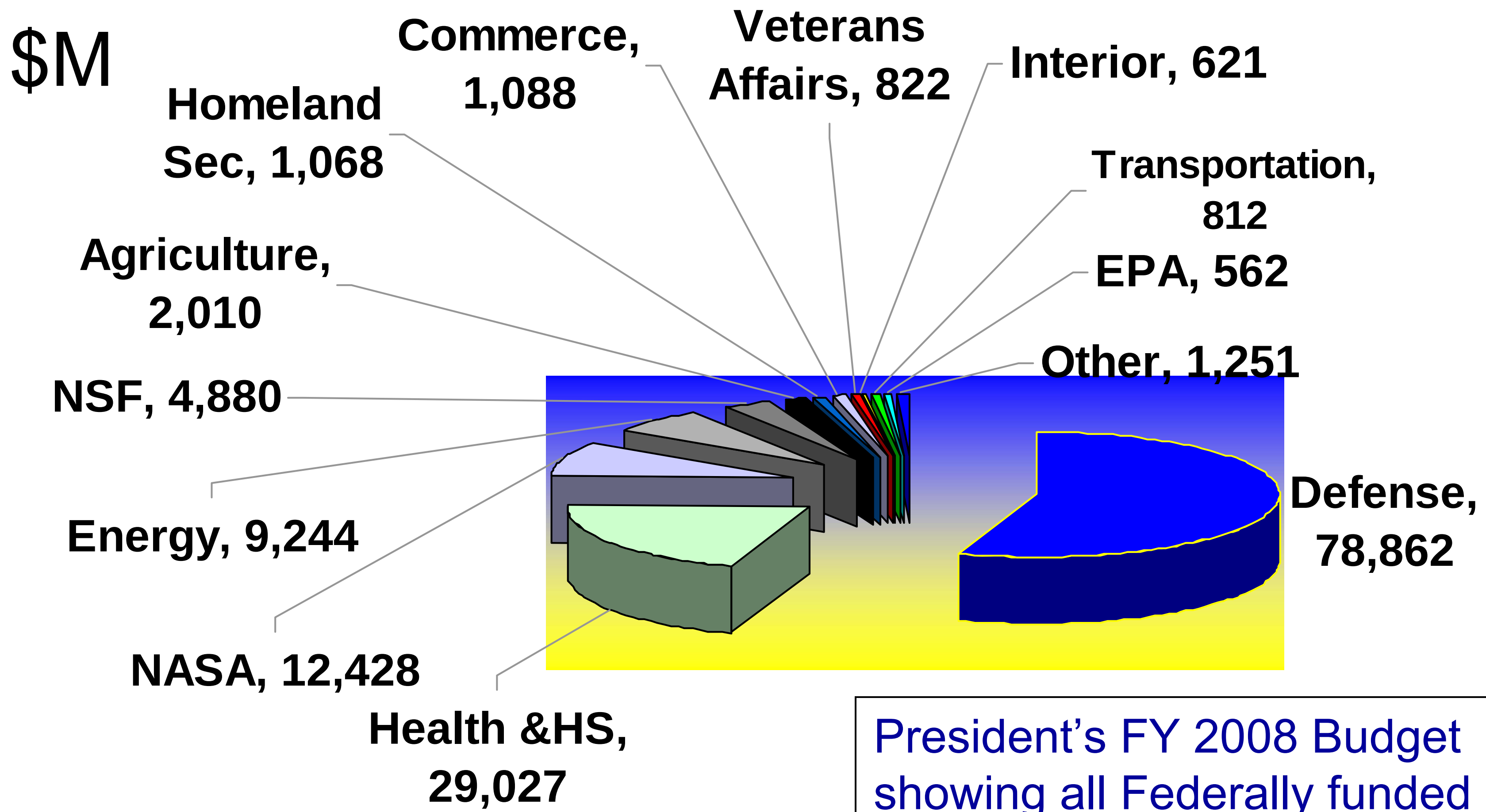
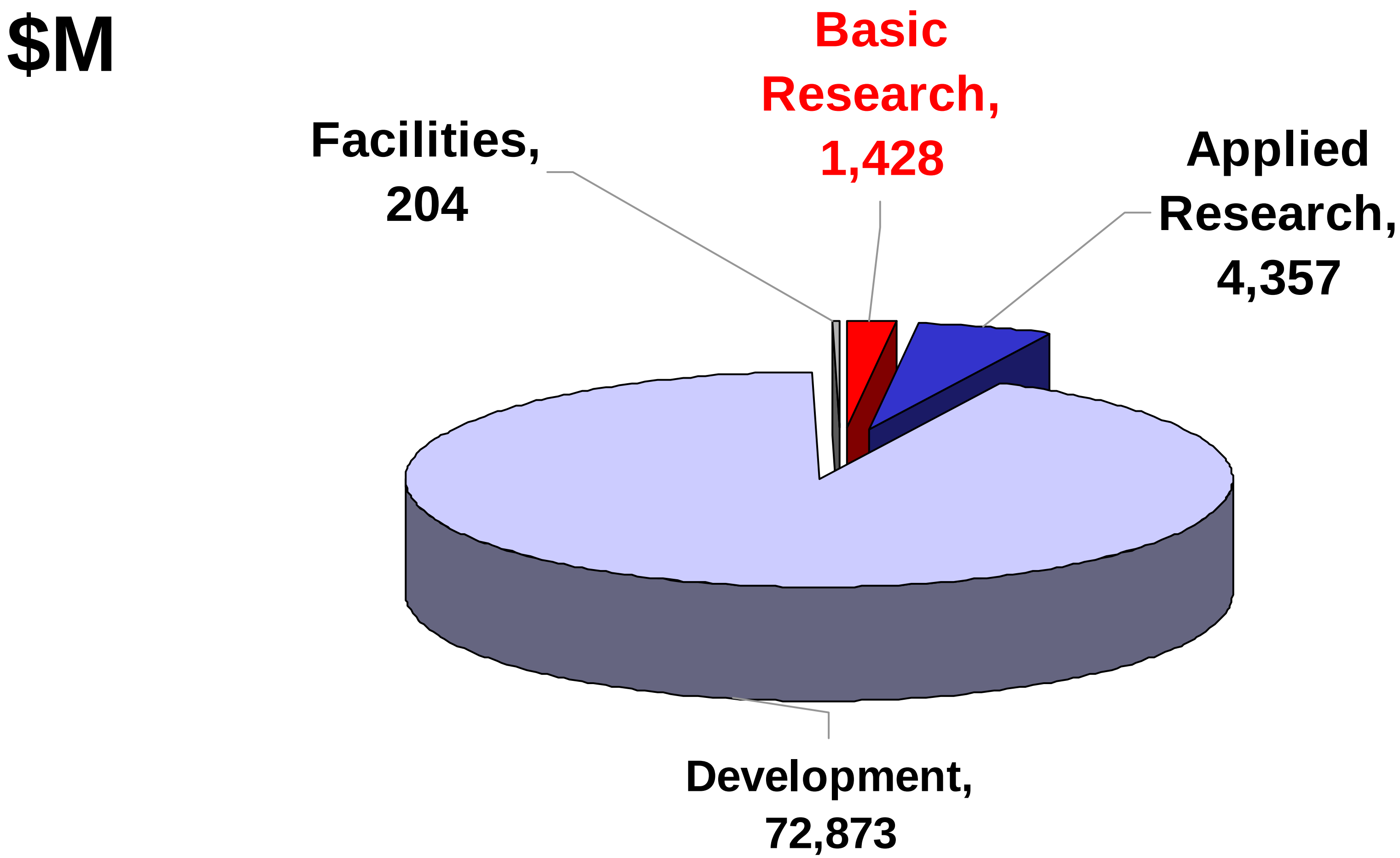
Federal R&D Funding



President's FY 2008 Budget showing all Federally funded Research and Development

Source: Federal Budget FY 2008 Analytical perspective, pg 51+ available at http://www.whitehouse.gov/omb/budget/fy2008/pdf/apers/crosscutting.pdf

DoD Research, Development, Test & Evaluation FY 2008



FY08 RDT&E request = $78.86B
(Budget Activities 1→7)

Source: Federal Budget FY 2008 Analytical perspective, pg 51+ available at http://www.whitehouse.gov/omb/budget/fy2008/pdf/apers/crosscutting.pdf

Main Purposes for Defense Basic Research

- Generate new knowledge and understanding as foundation for future defense technologies
- Train scientists and engineers in key disciplines for defense needs
- Sustain research infrastructure needed for continued performance of cutting-edge defense programs

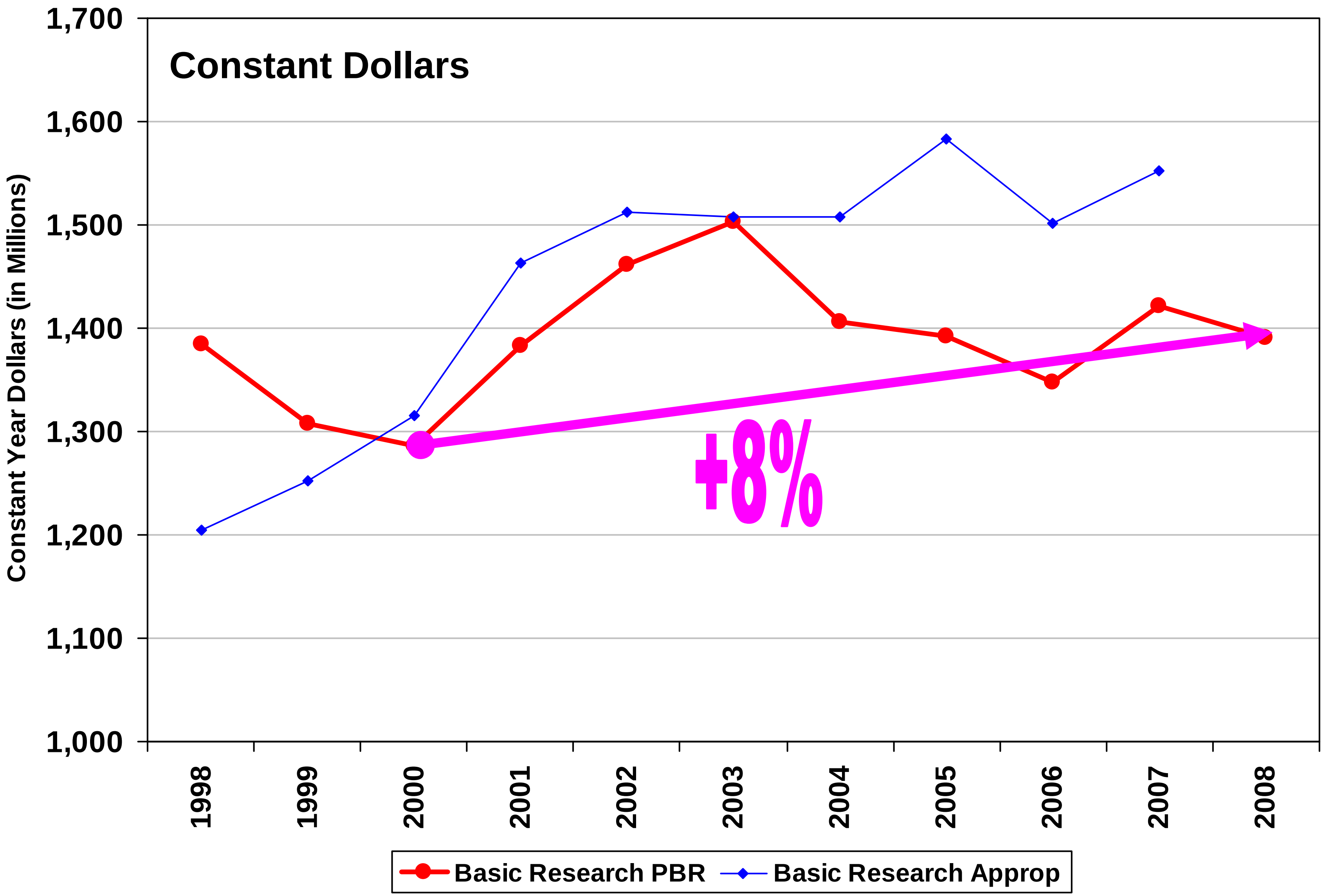
Overall S&T Priorities for FY08

Addresses Quadrennial Defense Review & Strategic Planning Guidance Capability Needs

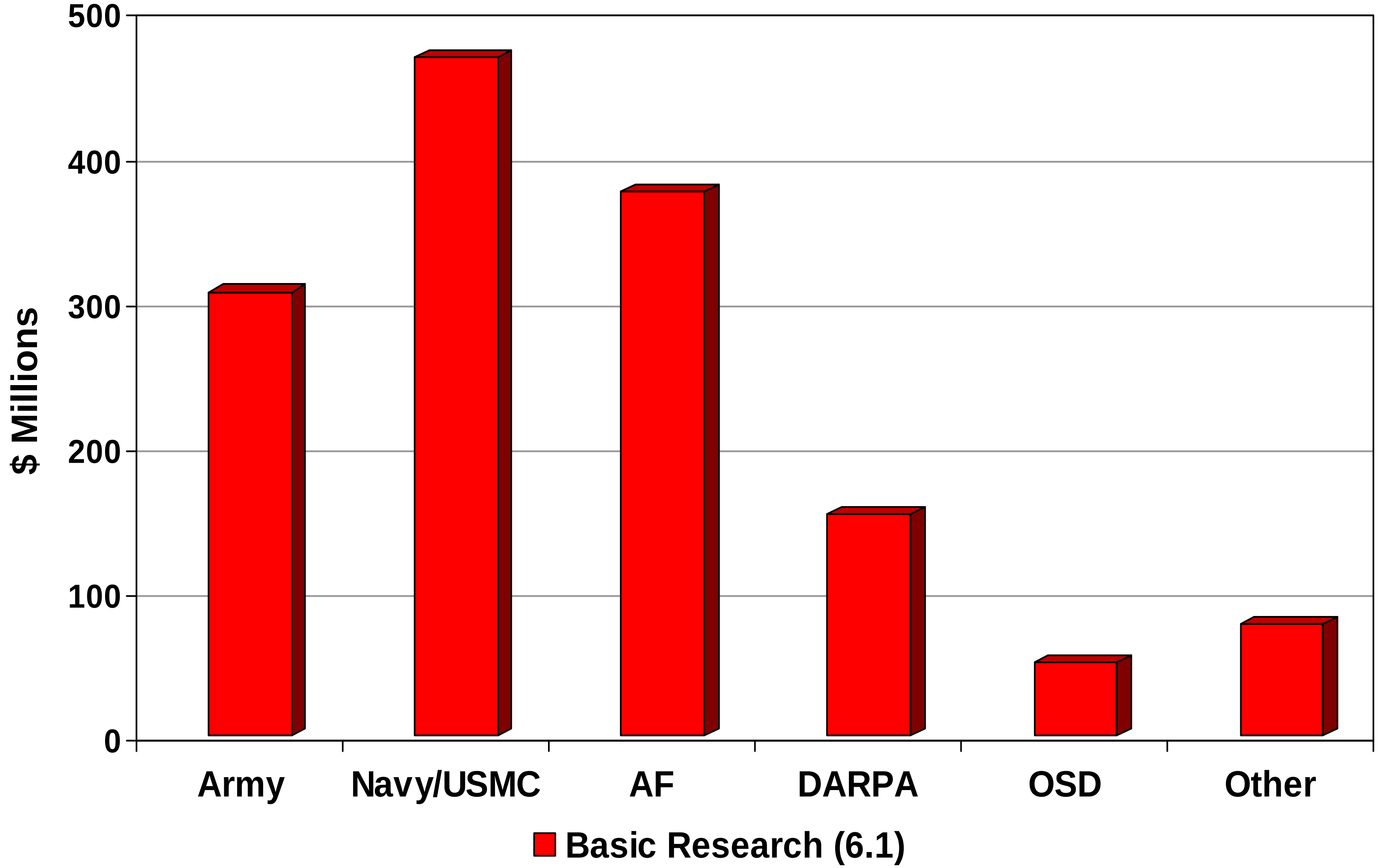
- **Capabilities to Defeat Terrorist Networks**
  - Biometrics
  - Human, Social, Cultural, and Behavioral Modeling
  - Clandestine Tagging, Tracking, and Locating
  - Airborne Hyperspectral
  - Synthetic Aperture Radar Change Detection
- **Capabilities to Defend the Homeland in Depth**
  - Joint Integrated Fire Control
  - Airborne Network Gateway
  - Network Communications Capabilities
- **Acquisition Affordability**
  - Defense-Wide Manufacturing Science & Technology
  - Insensitive Munitions Advanced Technology
  - Computational Research and Engineering Acquisition Tools and Environments (Project in High Performance Computing)

DoD S&T BASIC Research Funding FY1998-2008

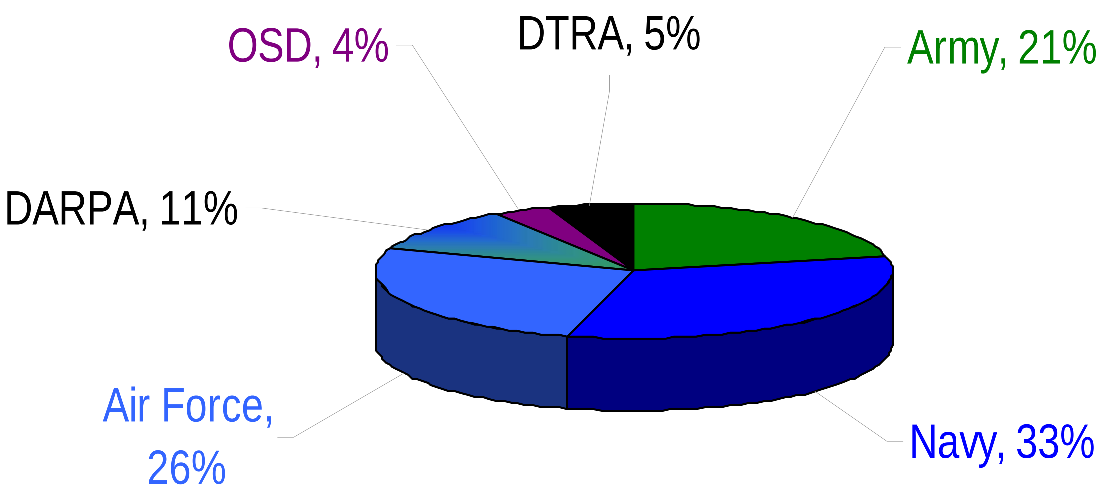
(President's Budget Request & Appropriated)



FY08 DoD 6.1 Budget Request

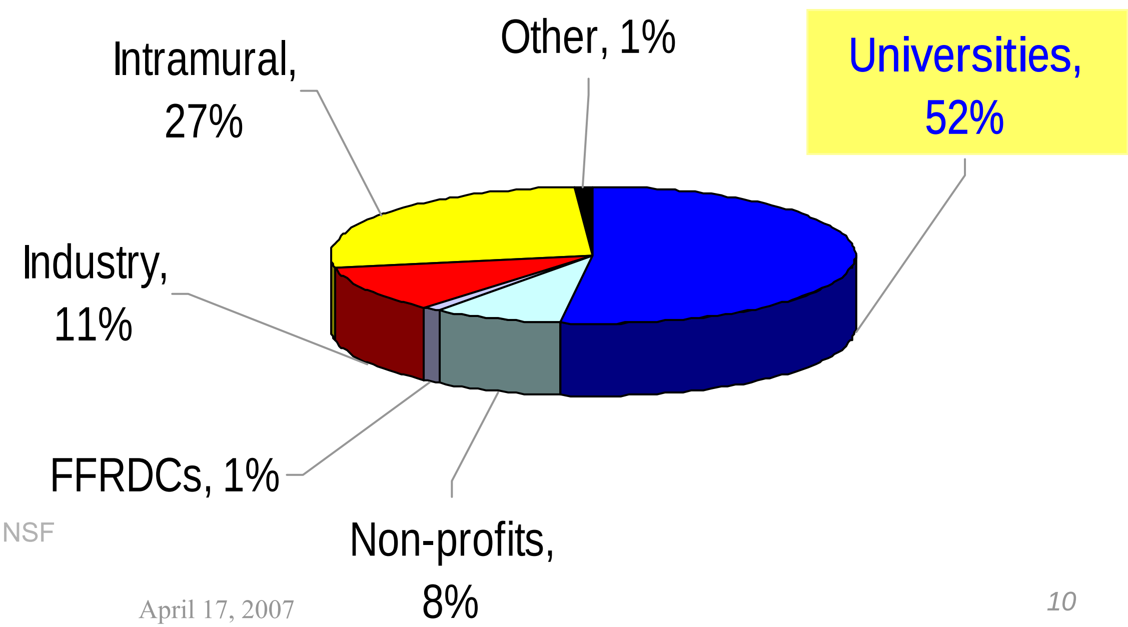


Sources & Destinations of Defense Basic Research Funding



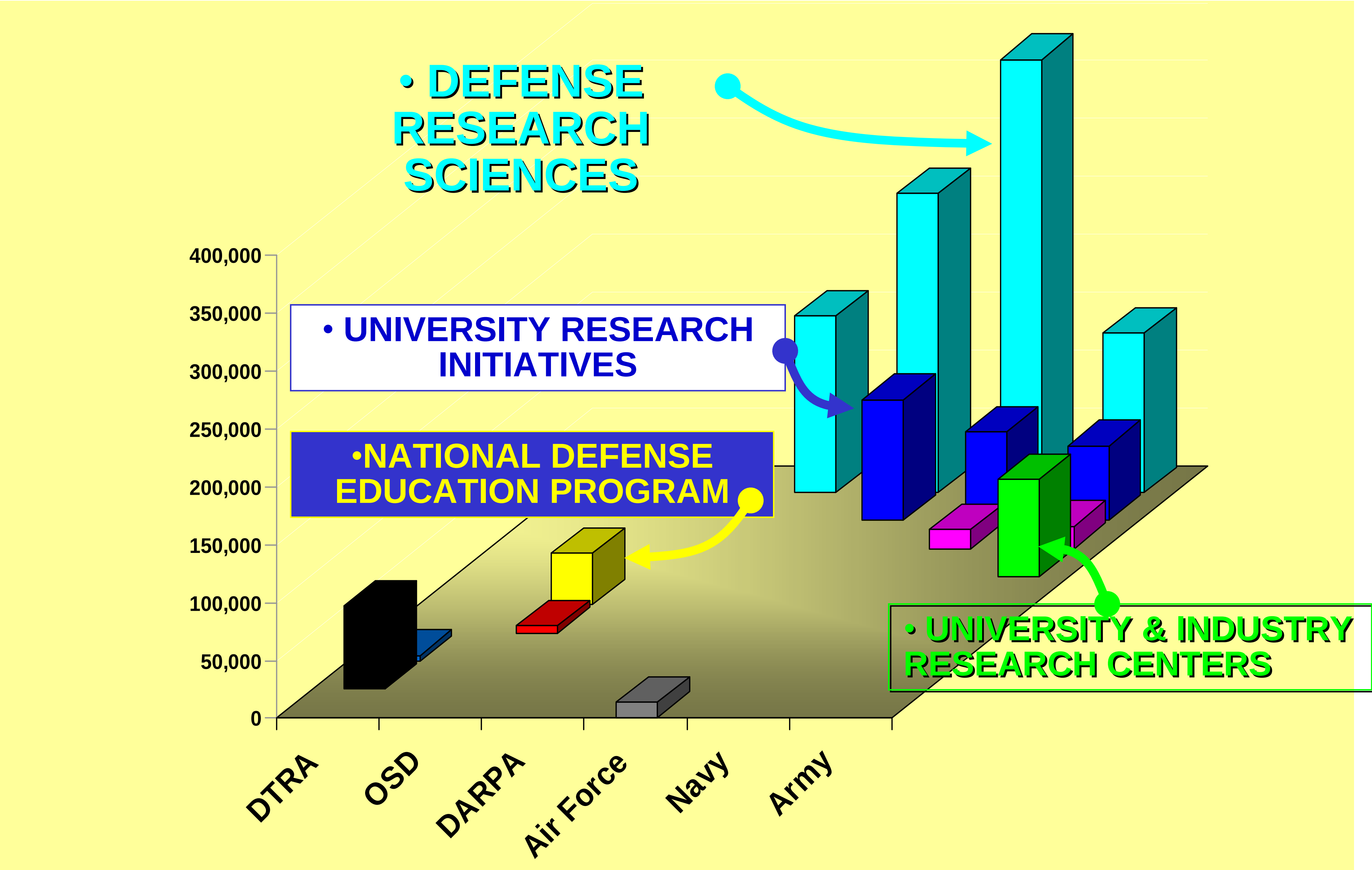
← Source 80% of Defense Basic Research ($1.42B) is Investments by Military Departments

Destination →
Performers of Defense Basic Research - 63% to Universities and Industry



Sources: FY08 President's Budget & DoD component inputs to NSF Federal Funds for R&D survey (FY05 – latest available)

FY08 President's Budget Request for DoD Basic Research



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Conceptual Strategic Planning Process

Joint Operational Capability Gaps

Joint Warfighting S&T Plan, QDR, Service Analyses, SPG

Not all joint operational gaps will have S&T capability gaps

Joint S&T Capability Gaps

Not all S&T capability gaps will demand basic research investment

Extant Service Basic Research programs, if successful, may provide solutions to some joint gaps

Map S&T gaps against Services' Basic Research Programs

Joint, Basic Research investment gaps

Department-level Basic Research investment guidance

classified

unclassified

Early-identified Areas of Exploration

Disciplines

- Atmospheric Sciences
- Biological Sciences
- Chemistry
- Cognitive and Neural Sciences
- Electronics
- Forensics
- Health Medicine and Biology
- Materials Science
- Mathematics and computer Sciences
- Modeling and Simulation
- Mechanics
- Physics
- Joint interoperable communications
- Offensive cyber warfare
- Energy efficiency
- Counter-IED

Mission-oriented

- Combating WMD Technologies
- Persistent Surveillance Technologies
- Alternative Fuels & Energy Sources
- Biometrics & Bio-inspired Technologies
- Tagging, Tracking, & Locating
- Directed Energy Technologies
- Anomalous Event Extraction From Massive Data Sets
- Human, Social, Cultural, & Behavioral Predictive Modeling
- Hyperspectral Sensors
- Organization, Fusion, & Selective Extraction of Data
- Manufacturing Technologies
  - Affordability and Producibility
  - Agile Fabrication
- Nanotechnology

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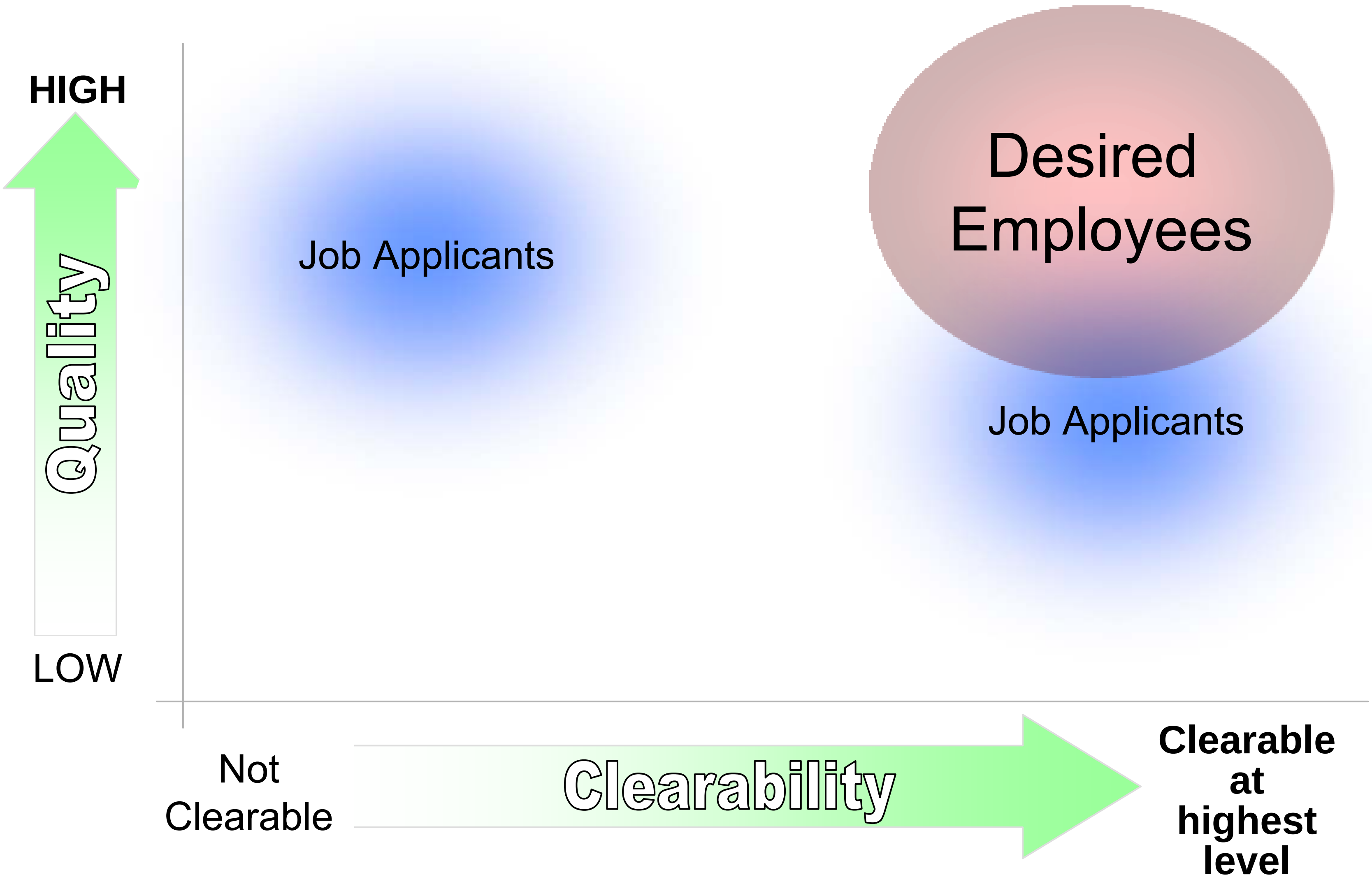
A Unique National Security Problem



Spectrum Of STEM Education

Middle School	High School	Undergrad / Grad	Faculty

Pre-Engineering Modules

Materials World Modules

SMART scholarships

N/S S&E Faculty Fellows

National Defense Education Program

- **Rationale**
- DOD employs nearly half of all Federal physical scientists, mathematicians, and engineers.
- DoD laboratories expect to lose 13,000 scientists and engineers by 2015.
- At the same time, demand for scientists is projected to increase by 17 percent, and for engineers by 22 percent.
- There is a long-term downward trend in defense-relevant science and engineering degrees (at all levels) awarded to personnel who could qualify for the security clearances.
- An April 2004 National Defense University report, The Science and Engineering Workforce and National Security, warns of the rapidly accelerating accumulation of intellectual capital, including an educated Science and Engineering (S&E) workforce, in China, India, Japan, South Korea, and Taiwan. This emphasis is in direct contrast to declining S&E education trends in the US.
- **Payoffs**
- A larger pool of high school graduates academically prepared and interested in physical science and engineering as their intended field of study.
- More clearable, proficient, academically degreed science and engineering workers for future national defense needs.
- In FY08, will have >100 grad (SMART) students, 9 NSSEF Fellows, and a growing K-12 enrichment program.

National Security Science and Engineering Faculty Fellowships

- National Security Science and Engineering Faculty Fellowships (NSSEFF) engages the best clearable, research university faculty to pursue long-term, critical DoD research.
  - A competitive award program that funds 50 top-flight university researchers over the FYDP and adds 10 more each year thereafter. (New Start FY08)
  - Grants are large enough to be attractive ($600K/yr) and long enough (five years) to produce quantifiable research results.
  - Pending Congressional approval, a $5.4M investment in FY08 starts the program with first 9 selectees and increases gradually to steady state of $30M annually in FY13.
  - Biased toward early-career faculty members, though not exclusively for them.
  - All awardees will carry security clearances and will work DoD problems up to the SECRET level.
- NSSEFF captures the best available, clearable university talent to pursue long-term DoD research.

SMART/ NDEP Program

National Defense Education Program (NDEP)

Science Mathematics and Research for Transformation (SMART)

- Comprehensive education and training = Shaped Workforce
- Scholarship/Fellowship (Associate through Ph.D.)
- Security clearable
- Defense Critical Disciplines
- Civil Service Payback required (set at 1 to 1 by policy)
- Employee status while enrolled
- ~40 awards in FY06 (30 in FY05)
- Have & maintain a minimum GPA 3.0 on 4.0 scale
- Post degree follow-up

Science and Engineering Enrichment

- **Materials World Modules (MWM)** supplement existing high school science curricula with hands-on projects. They engage students and teachers in partnership with DoD laboratory scientists and engineers.
  - FY06 Summer Institute
  - Kit-based curriculum enhancement using relevant learning segments (i.e. sports materials, concrete, biosensors, etc.) that combine the inquiry of science with the design of engineering
  - Impact experiment completed, first teacher training session completed
  - In an FY06 effect assessment, students exposed to MWM show 62% cognitive (knowledge) and very significant positive attitudinal gain toward science and engineering, in immediate post-exposure poll.
  - Additional components anticipated in FY07 & FY08

Science and Engineering Enrichment

Pre-Engineering Modules (PEM) are practical, middle school curriculum modules that tie math, physical science, and engineering to real-world applications. (New Start FY08)

- Require multiple tools in the tool kit to reach broad audience with sustained impact
- Invest in projects that are effective and efficient.
- Partner with existing programs as an option

Summary

- Universities perform over half of DoD 6.1
- DoD 6.1 research request has increased 8% since FY2000
- NDEP provides full spectrum of university support
  - Undergraduate students
  - Graduate students
  - Faculty

SMART

NSSEFF

DEPARTMENT OF DEFENSE

UNITED STATES OF AMERICA